MAY 9 1913

Engineering News

Issued Every Thursday
Hill Publishing Company

NEW YORK, MAY 8, 1913

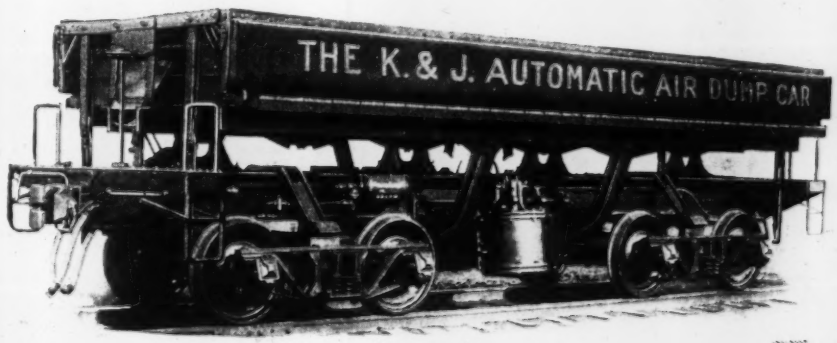
Price, 10 Cents. $5 Year
To Canada, $6. Foreign, $7

7

280 Cubic Yards dumped in Ten Seconds

With "K & J" Automatic Dump Cars

See Photo below taken on L. & N. R. R.



Owing to increased manufacturing facilities we now announce the "K & J" Automatic Air Dump Car.

Trains of these cars are in daily operation on the large railroad systems of the United States and Canada. So successful were they from the first that our manufacturing facilities were greatly taxed to fill orders that the record of their performance brought in.

We have greatly increased our manufacturing facilities and now make our first press announcement.

The car is ready and claims consideration on the basis of it's performance.

It carries 20 cu. yds. level load or 28 cu. yds. maximum. A 16--23 cu. yd. size is also built.

Air drawn from the air brake train line automatically unlocks and dumps the cars and automatically rights and relocks them.

The cars operate perfectly, regardless of how the load may be placed.

The entire train may be dumped at once or any number of cars may be dumped independently.

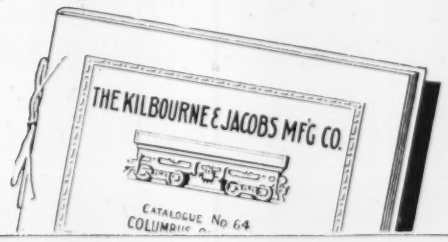
The entire train may be dumped either to the right or left, or alternate cars may be dumped right and left.

A single lever for each side governs the car's operation. Entire train may be dumped by an operator stationed on any car in the train.

Ten seconds dumps the entire train and ten seconds rights it again.

Notice the Puff of Dust

The Entire Train dumps at once, as shown by the Puff of Dust seen hanging above each car in Photo



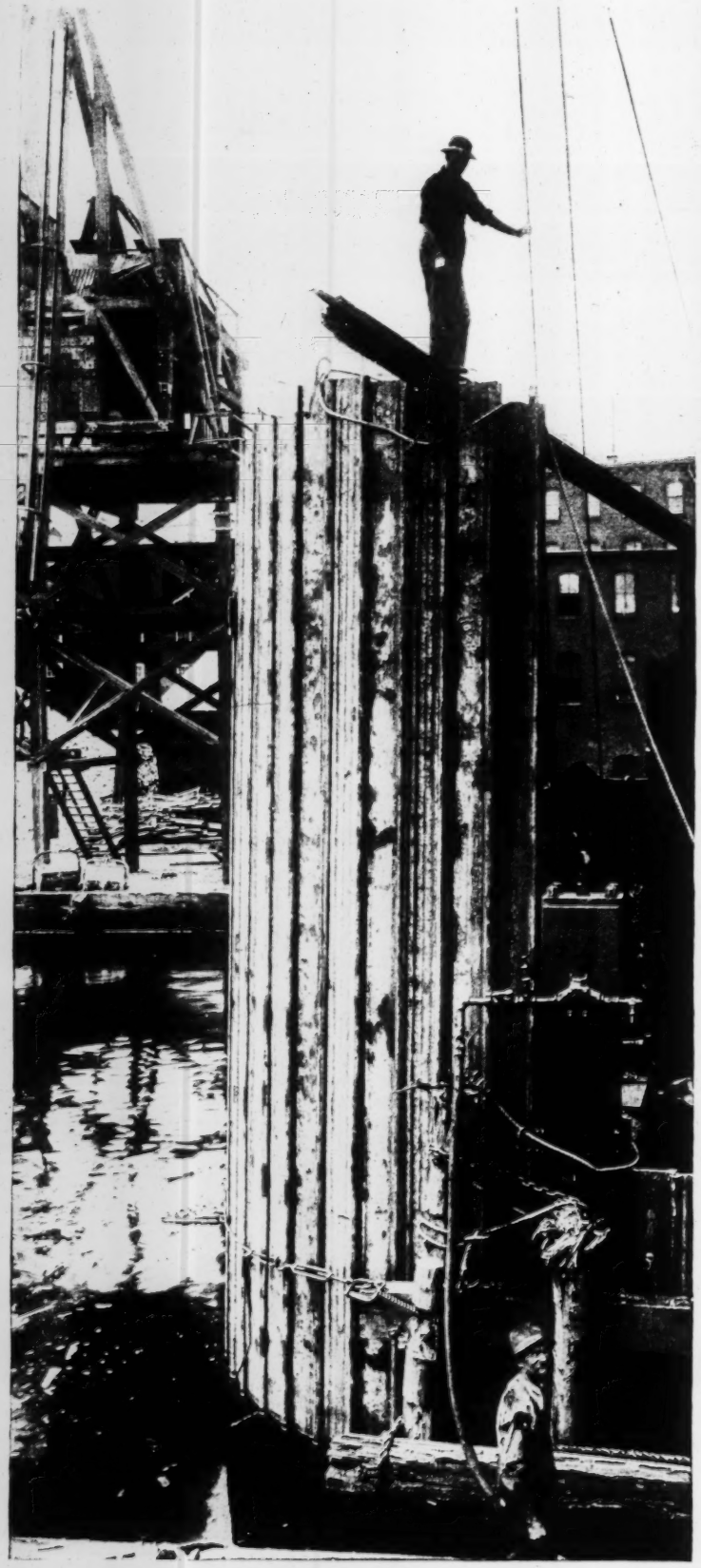
The Kilbourne & Jacobs Mfg. Co.

New York Columbus, Ohio, U.S.A. London

Ask for Catalogue No 64-A

A single-wall cofferdam that required water-tightness and driving among boulders but the Lackawanna Steel Sheet Piling made good

The driving of this cofferdam (Bridge St. Bridge, Newark, N. J., as mentioned in previous advertisements) was unusually difficult, yet the Lackawanna Steel Sheet Piling never failed or showed the slightest evidence of weakness. Many boulders were displaced or broken by the piles and in some instances completion of the driving had to be postponed until after partial excavation. After the steel sheet piles were all driven, the joints were thoroughly calked with oakum, rammed down from the top, to a depth of about 25 feet with thin steel rods, an operation which took six men about two weeks, for the 172 interlocks. The calking proved thoroughly efficient, enabling the cofferdam, composed of a single wall of piling (15 by 83 feet by 34 feet deep) to be pumped out and kept dry by a six-inch pump. As the bottom was excavated inside the cofferdam, some of the boulders which obstructed the sheet piles were left in position and the sides of the excavation below them were closed with bags of cement. The cofferdam resisted a pressure head of about 28 feet with very little leakage and presented a very regular appearance. The long sides of the cofferdam were braced with 12 x 12-inch horizontal transverse struts 9 feet 7 inches apart on centers in four tiers about 6 feet apart. At the rounded ends, the inside waling pieces were made of double scarf timbers like arched centers with radial braces to the middle of the adjacent cross strut.



After the completion of this pier, the Lackawanna Steel Sheet Piles used in its cofferdam will be pulled and redriven for the other similar pier.

This is but one of hundreds of instances where difficult or doubtful cofferdam work has been thoroughly successful by the use of Lackawanna Steel Sheet Piling. Tell us your piling requirements and our engineers will advise you to your best interests.

LACKAWANNA STEEL COMPANY

General Sales Office and Works: Lackawanna, N. Y.

NEW YORK
BOSTON
BUFFALO
PHILADELPHIA
CLEVELAND
CINCINNATI
CHICAGO
DETROIT
ST. LOUIS
ATLANTA
SAN FRANCISCO

73

Engineering News

CHARLES WHITING BAKER, *Editor*

Subscriptions payable in advance, $5.00 a year for 52 numbers, including postage in the United States, Mexico, Cuba, Porto Rico, Hawaii, or the Philippines, $7.00 in Canada.

Published Weekly By HILL PUBLISHING COMPANY
505 Pearl Street, New York, N. Y.

JOHN A. HILL, Pres. ROB'T MCKEAN, Sec'y.
Cable Address: "ENGNEWS"

To foreign countries, including postage, $9.00 or its equivalent, 38 shillings: 38 marks: or 45 francs. Notice to discontinue should be written to the New York Office in every instance. Advertising copy should reach New York Office by Thursday of week before date of issue. Entered at New York Post-office as mail matter of the second class.

VOLUME 69 MAY 8, 1913 NUMBER 19

CONTENTS

WITH PRINCIPAL ARTICLES SUMMARIZED

*Illustrated Article

*LOTSCHBERG RAILWAY IN SWITZERLAND: *Page* 935
Short description of some interesting features of a notable mountain railway. 500 w. 2 ill. ENGINEERING NEWS, May 8, 1913.

ELIMINATION OF TASTE IN WATER IN WATER TREATED WITH CALCIUM HYPOCHLORITE: *Page* 936
Abstract of a paper read at annual meeting of the Illinois Water Supply Association; results of tests and experiments. 3000 w. Arthur Lederer and Frank Bachmann. ENGINEERING NEWS, May 8, 1913.

*DREDGING PROBLEMS IN WILMINGTON HARBOR, DEL.: *Page* 938
Describes the constant silt deposition in the harbor; attempts to dredge and maintain a channel by ordinary hydraulic dredging methods; a proposed solution of the problem by use of the Frühling type of dredge. 4000 w. 2 ill. R. R. Raymond. ENGINEERING NEWS, May 8, 1913.

*DEPRECIATION AND PUBLIC-SERVICE REGULATION: *Page* 942
Discussion whether in a rate-regulation proceeding there should be a deduction from cost-new, on account of accrued depreciation due to age and wear and tear, though such appreciation does not interfere with the present efficiency of the plant. 7200 w. Robert H. Whitten. ENGINEERING NEWS, May 8, 1913.

*TRACK ELEVATION AT JOLIET, ILL.: *Page* 952
Describes exposure tests made by Westinghouse, Church, Kerr & Co., of both ready-mixed and straight red-lead paints, commonly used for structural steel work; results of tests; comparison of second-coat paints. 4000 w. 3 ill. Cloyd M. Chapman. ENGINEERING NEWS, May 8, 1913.

RESULTS OF ELECTRIC TRACTION ON THE NEW YORK CENTRAL R.R. AT NEW YORK CITY: *Page* 951
Brief summary of paper by E. B. Katte, before New York Railway Club. 200 w. ENGINEERING NEWS, May 8, 1913.

*TRACK ELEVATION AT JOILET, ILL.: *Page* 952
Description of work of eliminating grade crossings at a total cost of $2,000,000; general plan of the work and detailed designs of bridges and subways at street crossings. 2000 w. 5 ill. ENGINEERING NEWS, May 8, 1913.

*METHOD OF PROPORTIONING CONCRETE: *Page* 956
Describes various methods in use and their disadvantages; method proposed by author of determining the amount of cement in excess of the voids in the fine aggregate required to make an acceptable mortar and the amount of mortar in excess of the voids in the coarse aggregate required to make an acceptable concrete, and then determining the per cent. of voids in the aggregates, proportioning the ingredients so as to fulfill these requirements. 3600 w. 5 ill. William B. Hunter. ENGINEERING NEWS, May 8, 1913.

SOME RADICAL REFORMS IN THE CONDUCT OF PATENT LITIGATION: *Page* 958
Discussion of revised rules of practice for courts of equity in the United States. 2000 w. Gilbert H. Montague. ENGINEERING NEWS, May 8, 1913.

*NEW LOCOMOTIVE-TESTING PLANT: *Page* 960
Description of testing plant recently completed at the University of Illinois; special features of novelty and importance. 2000 w. 4 ill. Edward C. Schmidt. ENGINEERING NEWS, May 8, 1913.

*REPAIRS TO A REINFORCED-CONCRETE CHIMNEY: *Page* 962
Describes repairs to 160-ft. chimney built in 1903 for the power house of the Kansas-Missouri Elevator Co., Kansas City, Mo., and which was rendered unsafe by cracking due to heavy windstorms. 1200 w. 2 ill. C. E. Smith. ENGINEERING NEWS, May 8, 1913.

*TWO HEAVY RAILWAY BRIDGES WRECKED BY THE MIAMI RIVER: *Page* 965
Examples of amazing extent of bridge destruction in recent floods in the Middle West. 200 w. 4 ill. ENGINEERING NEWS, May 8, 1913.

STATUS OF ENGINEERING: *Page* 965
Extracts from an editorial in the "Contract Journal," London, England. 500 w. ENGINEERING NEWS, May 8, 1913.

NOTES ON THE FLOOD IN THE LOWER MISSISSIPPI: *Page* 965
Describes flood conditions compared with previous floods; levee situation; flood protection schemes. 1000 w. A. L. Dabney. ENGINEERING NEWS, May 8, 1913.

ORGANIZATION AND FUNCTIONS OF A CITY-PLANNING COMMISSION: *Page* 977
Abstract of a paper read at National Conference on City Planning in Chicago, Ill. 1000 w. Wm. A. Magee. ENGINEERING NEWS, May 8, 1913.

GOVERNMENT AID IN LAND DRAINAGE: *Page* 978
Abstract of a paper read before the National Drainage Congress; arguments against drainage work by the government; proper field for government assistance. 2200 w. Arthur E. Morgan. ENGINEERING NEWS, May 8, 1913.

*TESTS OF GROUTING GRAVEL IN RIVER BEDS: *Page* 979
Describes tests of method of forming a foundation stratum at proper depth by forcing cement grout into the soft foundation material by means of compressed air; Cumberland River Bridge of the Louisville & Nashville R.R., at Nashville, Tenn. 3600 w. 10 ill. H. H. Cartwright. ENGINEERING NEWS, May 8, 1913.

EDITORIALS: *Page* 967
LETTERS: *Page* 970
NOTES FROM ENGINEERING SCHOOLS: *Page* 984
ENGINEERING NEWS OF THE WEEK: *Page* 986
PERSONALS: *Page* 987
ENGINEERING SOCIETIES: *Page* 988
CONSTRUCTION NEWS: *Page* 47
CONTRACTS TO BE LET: *Page* 68
WANT ADVERTISEMENTS: *Page* 74
ADVERTISING INDEX: *Page* 128

CIRCULATION OF THIS NUMBER OF ENGINEERING NEWS 20,000
None sent free regularly, no returns from news companies, no back numbers

WHAT THE BUYER NEEDS TO KNOW

Number Nineteen

There is at least one class of advertising which need not be educational nor inspiring nor full of human interest, nor any of the various other things that advertising is popularly supposed to be in these days.

But it must be easy to find and arranged with a full-sized regard for the convenience of the buyer.

We refer to the advertising of second-hand machinery and material.

And in order that this cardinal principle of convenience may be carried out—

We have arranged a "Classified List" of second-hand machinery and material, which will appear regularly.

You will find it beginning on page 76 of this issue.

We purpose to make this a live, up-to-the-minute directory of machinery and material, ready for instant reference and quick assimilation.

It will include machinery for sale, rent, exchange and wanted.

It will be "headquarters" for the buyer who wants machinery or material in a hurry and for whom it need not be new.

And it is without doubt the best place for the seller of second-hand machinery and material in this field to dispose of his wares.

We hope to render a quick and reliable service to the man with something to sell and to the man who is in the market.

The introduction takes place weekly in the "Classified List."

Engineering News

VOLUME 69 MAY 8, 1913 NUMBER 19

The Loetschberg Railway in Switzerland

The accompanying views show some of the notable high masonry viaducts on the new Lötschberg Ry., Switzerland, which has just been opened for traffic. As our readers will recall, from previous descriptions of this railway line in this journal, this new line gives a direct connection from Berne, the capital of Switzerland, southward to a junction in the upper part of the Rhone valley with the main line to Italy through the Simplon tunnel.

The new line begins at Spiez on Lake Thun (which is seen in the background in the photograph showing one of the electric locomotives used on the line). The first section from Spiez to Frutigen has been in operation for several years. From Frutigen the line follows the left side of the Kander, a swift current which descends a narrow valley on either side of which lofty snow-covered peaks seem to overhang. The ascent becomes steeper as the head of the valley is approached. The highway up the valley zigzags back and forth seven times at one point, and on the railway line much development was necessary and a loop was introduced at one point. At Kandersteg the line enters the nine-mile tunnel under the great Alpine Mountain mass of which the Jungfrau, only a few miles further west, forms a part. This tunnel is noted not only for its great length, but because of the terrible accident which occurred during its early construction, by which a long stretch of the tunnel was filled by an influx of sand and gravel from a mountain torrent above.

At the southern end of the tunnel the line emerges into the wild and precipitous Lötscher valley, where avalanches are so frequent that barriers were built at various points on the mountain-side above the line to break their force. From the Lötscher valley the line emerges into the broad valley of the Rhone, but at an elevation of 1000 ft. above the river, and it runs for a long distance along the precipitous mountain side, until it makes a junction with the Simplon line near the entrance of the Simplon tunnel.

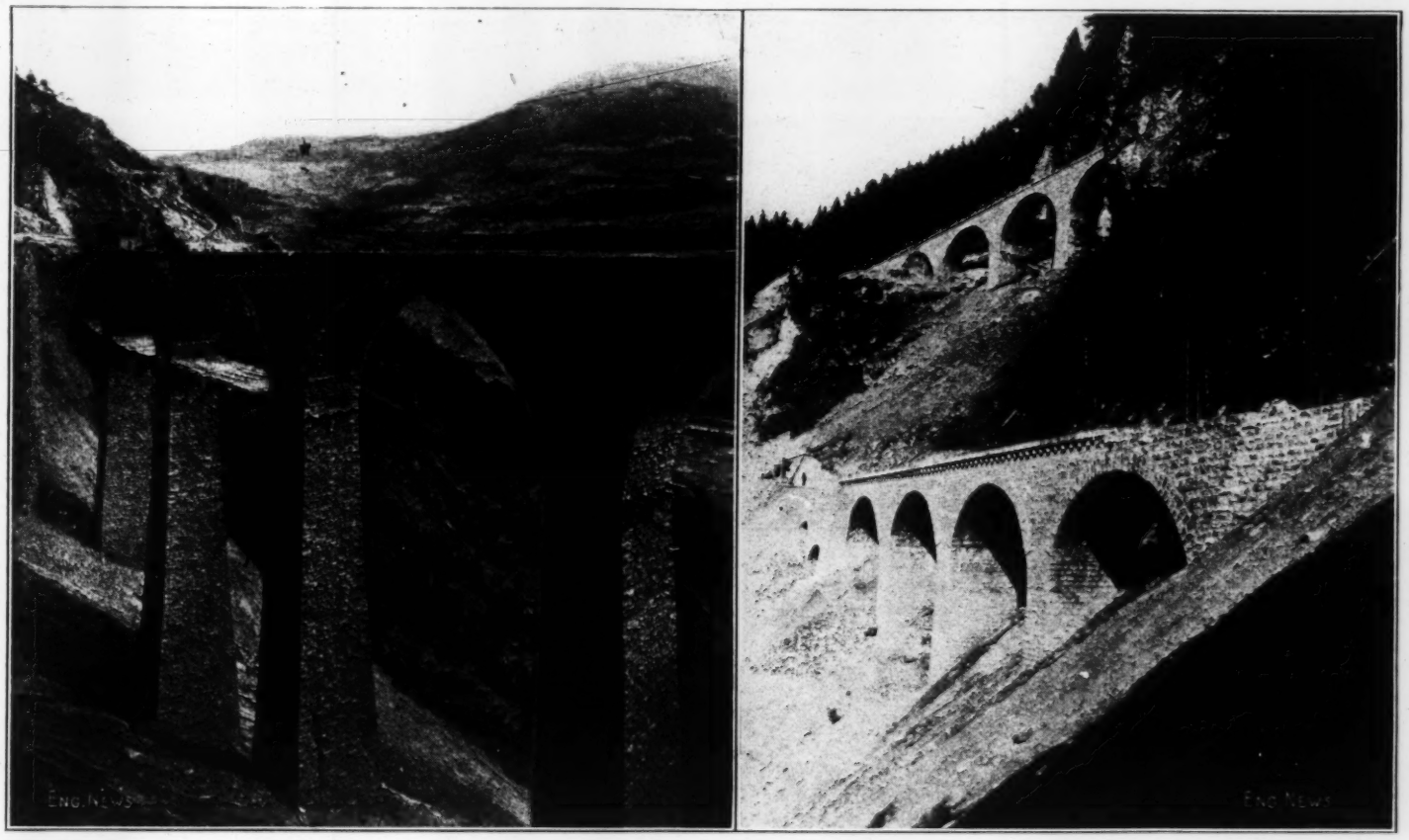


FIG. 1. MASONRY VIADUCTS ON THE LOETSCHBERG RY., SWITZERLAND

The electric locomotives which are used on this line resemble in general design the electric locomotives used on the Pennsylvania R.R. terminals in New York City, having their driving wheels connected by parallel rods as in steam locomotive practice. They are probably the largest electric locomotives in Europe, developing approximately 2000 hp., and being capable of hauling a train of 310 tons weight on a grade of 2.7% at a speed of 26 mi. per hr.

The Elimination of Taste in Water Treated with Calcium Hypochlorite*

By Arthur Lederer† and Frank Bachmann‡

It is surprising that the problem of removing the taste from waters treated with chlorinated lime has received such scant attention in this country. More water-supplies are treated with chlorinated lime in the United States than in any other country of the world, yet while we frequently hear complaints about the taste of treated waters, which very often are justified, we have heard practically nothing about the remedies. We even know of cases where high concentrations of chlorinated lime accompanied by a taste have been accepted as an unavoidable evil, which could not be remedied except by decreasing the efficiency of the disinfection process.

The first experiments on the removal of taste due to chlorinated lime were made almost 20 years ago by Traube[1], who also was the first one to recommend chlorinated lime for the disinfection of water-supplies, although its germicidal action was known before. Traube applied 4.26 mg. of chlorinated lime containing 1.06 mg. of available chlorine to 1 liter of water and added after two hours contact 2.09 mg. of sodium sulphite. He claimed that an excess of sulphite up to 50% over the required quantity does no harm for the reason that the salt is quickly oxidized in the water to sodium sulphate, which cannot be tasted in such low concentrations. For 1,000,000 gal. of water Traube recommended 35.7 lb. of chlorinated lime and 16.8 lb. of sodium sulphite. The quantity of chlorinated lime applied may seem abnormally high in the light of more recent observations and experiences in this country, but it explains why the early observers were forced to look for means to remove the repugnant aftertaste in waters thus overdosed.

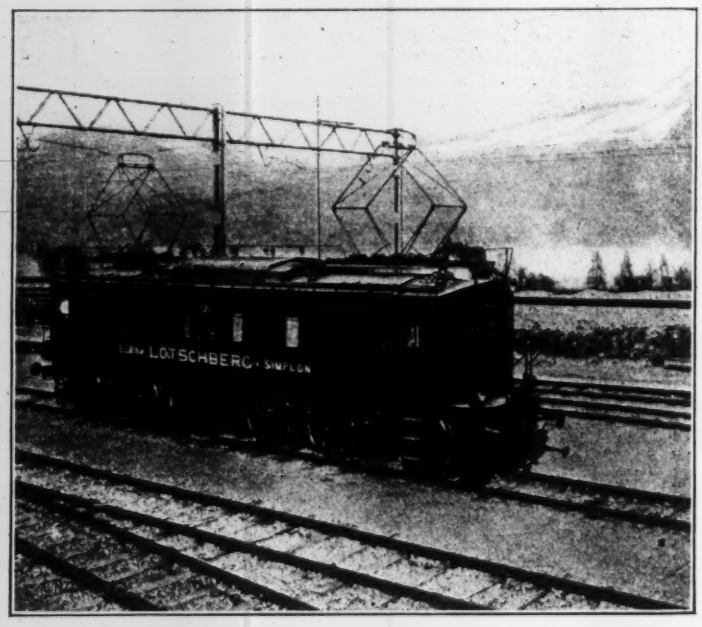


Fig. 2. One of the Loetschberg Electric Locomotives

The need for remedial measures grew still more pronounced when later observers like Bassenge[2], Sickenberger and Kaufmann[3], and Lode[4] were led by laboratory tests to employ still larger quantities of chlorine in the form of chlorinated lime or sodium hypochlorite. Sickenberger and Kaufmann disinfected the turbid Nile water at Cairo with sodium hypochlorite equivalent to 2 mg. of available chlorine per liter, which corresponds to about 50 lb. of chlorinated lime per million gallons of water.

Bassenge recommended for disinfection on a large scale the enormous quantities of 2445 lb. of chlorinated lime for a ten-minute contact period down to 270 lb. of chlorinated lime for two hours contact. To eliminate the taste a quantity of calcium bisulphite somewhat higher than the quantity of chlorinated lime employed had to be added. Bassenge decided on the use of calcium bisulphite for the neutralization of the excess-chlorine with the advice of Dr. Proskauer. Calcium bisulphite is a saturated solution of calcium sulphite in sulphurous acid. It has the strong odor of that acid. On standing it decomposes, forming calcium sulphite and water. The reason Bassenge did not make use of sodium sulphite, as did Traube, was that it forms sodium sulphate in sufficiently large quantities to have a marked therapeutic effect which would not be the case with calcium bisulphite. An additional reason was that the free acid present would more readily combine with the chlorine than would the neutral sulphite. No definite quantity of bisulphite was recommended since it rapidly changes on storage. The quantity had to be determined each time by actual trial. Lode likewise used excessive quantities of chlorinated lime and advised the use of either sodium or calcium sulphite for the neutralization of the chlorine after 5 to 10 min. contact. In a later publication [5] he goes quite thoroughly into the question of removing the taste by various chemicals, of which he prefers the neutral sodium sulphite but still recommends for disinfection quantities of chlorinated lime as high as 1250 lb. per million gallons of water.

It is also interesting to note, in connection with the early disinfection experiments, that acids were brought into contact with the water after the chlorinated lime has been added in order to liberate the active chlorine which otherwise would not enter into the reaction. Lode adds for each pound of chlorinated lime about 1.2 lb. of concentrated hydrochloric acid. Citric acid likewise has been used in quantities of approximately 15 grains per gallon of chlorinated water for the same purpose. It is said that the taste was not influenced by the addition of the citric acid.

From the foregoing it must be apparent that even if the taste was effectively removed by the addition of various chemicals, the treatment of water-supplies at that time must have proved too expensive to be considered anything more than a temporary relief measure in times of epidemics. As such the Traube-Lode process was employed during a typhoid epidemic at Pola (Austria) in the fall of 1896 and the winter of 1896-97 by Dr. Meerans[6] on the recommendation of v. Kusy. A total of 45,000 gal. of treated water was supplied during that period and sodium thiosulphate served for the elimination of the taste. The consumers became eventually used to the water in spite of its high turbidity resulting from the chlorinated lime treatment. Lode criticized the use of sodium hyposulphite in Pola and assumed that it had been used by mistake, since in his earlier writings, he called the sodium sulphite "antichlor" which as a matter of fact is the trade name for sodium thiosulphate. The uncertainty of the quantity of chlorinated lime to be added to different waters and the almost general introduction of safer ground-water supplies led the Germans to abandon altogether this treatment as a permanent procedure.

There are, however, industrial regions in Germany where similar conditions exist in regard to water-supplies as in this country, which have caused renewed interest in the hypochlorite treatment. Such conditions are met with in the coal mining region of the Ruhr watershed and disinfection of more than a dozen water-works supplies carried by on H. Bruns[7] with quantities somewhat smaller than those originally employed by Traube gave, with two exceptions, very satisfactory results. The quantities of chlorinated lime varied between 12.5 to 25 lb. (containing approximately 33% of available chlorine) per 1,000,000 gal. While complaints were frequent when the treated water was used by the consumers, the complaints ceased as soon as sodium thiosulphate was added as a routine measure. The compound was added 15 to 30 min. after disinfection in quantities equivalent to 50 to 70% of the weight of the chlorinated lime. As noted above, the disinfection was a failure in two cases. In one case the organic contents of the water expressed as "oxygen consumed" reached as high as 30 p.p.m. (parts per million) and in the other case the water contained 2 p.p.m. of iron.

The good results obtained on adding taste-removing chemicals induced us to believe that like results could be obtained in our "hypo" plants where the amount of chlorinated lime approaches the limit of recognizable taste. In some of our former observation[8] we found that 0.6 p.p.m. of available chlorine (equivalent to 15 lb. of chlorinated lime per 1,000,000 gal.) was about the smallest quantity which could be readily tasted, but it is a fact that even smaller quantities are discerned by sensitive non-smoking consumers, particularly when the temperature of the water is high. We should remember that in plants where

---

*Abstract of a paper read at the annual meeting of the Illinois Water Supply Association, March 11 and 12, 1913.

†Chemist and Bacteriologist, the Sanitary District of Chicago, Chicago.

‡Assistant Chemist, The Sanitary District of Chicago.

[1]Z. Hyg. 1895, p. 227.

[2]Z. Hyg. 1895, p. 227.

[3]La sterilisation de l'eau par l'hypochlorite de sodium. Le Progré. Journal Quotidien paraissant au Cairo. Dec. 13, 1894.

[4]Arch. Hyg. 1895, p. 236.

[5]Hyg. Rundschau 1899, p. 861.

[6]Die Typhusepidemie in Pola im Herbst 1896 und im Winter 1896-1897. Osterr. Sanitätswesen. Beil. zu No. 52, Dec. 29, 1898.

[7]J. Gasbel. 1912. pp. 649-56.

[8]Paper read before the Illinois Water Supply Association, Urbana, Ill., March 5, 1912.

smaller quantities, such as 6 to 8 lb. per 1,000,000 gal., are employed, accidental overdosing followed by a flood of complaints is frequent.

W. H. Dittoe and R. F. MacDowell[9] in reporting on the result of an inquiry among a large number of cities in United States and Canada, in which "hypo" treatment is installed, state that a taste is not often noticed when chlorinated lime is applied in quantities of 7 lb. per 1,000,000 gal. or less, but that there is often complaint on using larger quantities. With certain waters even smaller quantities may produce tastes and odors, however. It would then seem an advantage to apply a remedy if this can be done without materially influencing the cost of the treatment.

Our tests have been made on Lake Michigan water and while the relation of the chlorine to the chemicals applied theoretically remains the same, it is possible that the actual quantities would require adjustment with different water-supplies.

We know that storage of chlorinated waters by itself is a simple method by which to rid the water of the taste depending on the time allowed for this purpose. The chlorine taste in lake water treated with 12.5 lb. per 1,000,000 gal. disappeared, at room temperature, in a little over 3 hr. Simple aeration will hasten the disappearance, reducing the time to something like 2 hr. with the same quantity of bleach. The amount of air applied was 0.3 cu.ft. per gal. of water. It may also be stated here that the elimination of the taste coincides well with the disappearance of the potassium iodide-starch reaction. There is no definite chemical reaction taking place on aeration which would account for the speedier elimination of the taste; the chlorine seems to be carried off by the air bubbles passing through the liquid. On a large scale a prolonged storage period or storage with additional aeration would be in most cases not a practicable procedure. Contact of chlorinated water with wood charcoal will quickly do away with the chlorine taste, but the water in our experiments absorbed certain ingredients from the charcoal which by themselves resulted in a pronounced taste. Whether other carbonaceous material will give like results we do not know, but it is certain that sedimentation or filtration would be subsequently required to rid the water of the matter in suspension.

The chemicals which seemed of value for the purpose of removing the chlorine taste from waters are sodium sulphite and sodium thiosulphate, both of which are strong reducing agents and form tasteless compounds when brought into contact with chlorine. The calcium sulphite and calcium bisulphite which have been employed by some early observers have not been utilized by us for the reason that they are not readily obtainable and too expensive for practical application even when bought in bulk.

Our experiments on the neutralization with sodium sulphite were made on lake water treated with chlorinated lime as well as free freshly generated chlorine and practical tests coincided well with the theoretical quantities of chemical as determined by calculation. For 0.01569 gm. of bleach containing approximately 33% of available chlorine 0.01815 gm. of crystalline sodium sulphite were required, or 1.2 lb. of sulphite for each pound of chlorinated lime. One pound of liquid 100% chlorine would necessitate the addition of approximately 3.6 lb. of crystalline sodium sulphite for neutralization. An important point to keep in mind is that it takes as much sulphite for the free chlorine as for the total available chlorine in chlorinated lime to remove the taste of treated waters. The reaction between the sulphite and the chlorine takes place instantaneously, thus removing the taste as well as the odor at the same time. No harm can be done with a reasonable overdose since the sulphite could not be detected in such low concentrations. Furthermore it would take but a very short time for the dissolved oxygen in the water to convert the sulphites into sulphates.

Medicinally the sulphites are of low toxicity and fairly strong antiseptics on account of their ability to withdraw oxygen from organic matter but they are rarely used nowadays for that purpose. The average medicinal dose is 15 grains. Supposing we overdose a treated water containing 10 lb. of chlorinated lime per 1,000,000 gal. with 50% of the quantity of sulphite required, which would be an excess of 6 lb., one would have to drink about 370 gal. of the water to get a single medicinal dose, not considering any oxidation into sulphates at all. Since the medicinal dose of the sodium sulphate, which is formed in the reaction, is 240 grains its therapeutic effect is surely negligible.

The wholesale price of crystalline sodium sulphite is approximately 4c. per lb. in 100-lb. lots. This would add about 125% to the cost of the chlorinated lime, assuming that the market price of lime (containing 33% of available chlorine) is 2½c. per lb. Considering the benefit to be derived in many cases from the use of the sulphite the additional cost would not seem unreasonable. There are, however, serious drawbacks to the continued use of sodium sulphite, one of which is the fact that it deteriorates readily, forming sulphates which of course are completely inert as far as the taste-removing property is concerned. Weak solutions in particular will change from day to day.

The sodium thiosulphate as first applied in Pola and recently recommended by Bruns has striking advantages over the sodium sulphite. It is commercially used very extensively as "antichlor." When sodium sulphite comes into contact with chlorine the reaction taking place is the same as with iodines. With thiosulphate the oxidation is more complete and this therefore alters materially the proportions of chlorinated lime and thiosulphate necessary to do away with the taste and odor. The acids formed in the nuetralization process immediately combine with bases to form neutral salts.

Lode stated that in his experiments he found it impossible to establish quantitatively corresponding values of chlorine and thiosulphate and he recommended 0.8 to 0.9 of the quantity of the chlorinated lime for the purpose of taste removal. Bruns recommends values of 50 to 70% of the quantity of chlorinated lime applied. As a matter of fact it seemed impossible in our experiments to obtain checks when a chlorinated lime solution was titrated with a thiosulphate solution under addition of potassium iodide and starch in the absence of acid. Of course when acid was added and all of the available chlorine became liberated checks were readily obtainable. This was likewise the case when the same definite quantity of potassium iodide was added each time without acid and the solution immediately titrated. We have found, however, that the theoretical quantity of thiosulphate necessary to complete the reaction and remove the taste as well as odor coincided always with the amount necessary to satisfy the total available chlorine in the chlorinated lime employed. For one pound of chlorinated lime containing approximately 33% of available chlorine the theoretical quantity would be 0.28 lb. of crystalline thiosulphate or approximately 30% of the weight of the chlorinated lime. One need not be afraid to add an excess since even 100 lb. of thiosulphate in 1,000,000 gal. of pure water cannot be tasted. As a matter of fact we should strongly recommend the application of thiosulphate in quantities of half of the quantity of the chlorinated lime to be on the safe side at all times and to take care of all reasonable overdosing with chlorine.

The commercial sodium thiosulphate is about 98% pure. It is a colorless, odorless salt possessing a cooling taste, afterwards bitter. It is very stable in air below 92° F., but loses moisture above that temperature. It greatly exceeds the chlorinated lime in stability. The salt is readily soluble in water and neutral or faintly alkaline in reaction. The medicinal dose of thiosulphate is the same as that of the sodium sulphite. Formerly it has been used to a limited extent as a weak antiseptic. The price of the commercial preparation is about 1.85c. per lb. in 100-lb. lots; it is therefore cheaper than chlorinated lime.

To summarize the advantages of the sodium thiosulphate over the sodium sulphite we would say that it is much more stable, much cheaper and that it requires less in actual weight to accomplish the same result. The combined cost of the treatment is within easy reach of a community since it adds but 40% to the cost of the chlorinated lime and the advantage of its application will best be appreciated in places where taste troubles are frequent. Even when less than the theoretical quantity of thiosulphate is added it is bound to lessen the frequency of complaints. A very important point to keep in mind when such treatment is resorted to is that the thiosulphate stops the germicidal action of chlorine the moment it comes into contact with the treated water. This is not of serious consequences, however, since we know positively that the destruction of bacteria by the chlorine is extremely rapid and in most cases practically completed in the first five minutes. We should recommend, however, at least 10 to 15 minutes as a safe margin or even more when conditions warrant. When the chlorinated water is stored, the simple addition of the thiosulphate in solution will suffice, care only being required to obtain a fair distribution. There is not much chance for the thiosulphate to unite with substances other than chlorine, since those compounds have a pronounced chemical affinity. Where the treated water is directly discharged into the mains, without previous storage, provisions will have to be made to dose the treated water continuously with thiosulphate at a point where disinfection has been practically completed. The thiosulphate does not attack metals and therefore would not cause trouble in the dosing chamber as does the chlorine. Where quantities like 2 to 5 lb. of chlorinated lime are applied and the dosing can be made reasonably automatic the application of thiosulphate will hardly seem necessary. However, where larger quantities are required and taste troubles ensue our observations would lead us to recommend the application of sodium thiosulphate as a permanent procedure.

[9]Monthly Bulletin, Ohio State Board of Health, October, 1912.

Dredging Problems in Wilmington Harbor, Delaware

By R. R. Raymond*

When Wilmington was originally settled, the first firm land encountered by vessels sailing from the Delaware River into what is now Wilmington harbor was called "The Rocks," and this point is now marked by a monument near the Fourth St. wharf. The land lying upstream from this point and stretching northward and westward is high and hilly, while that on the south side of the river is low, marshy and formerly was washed by high tides (Fig. 1).

Except where the high land touches the Christiana River within the city limits, the valley of the Christiana is low and level. The Brandywine River, however, flows through a deep and rocky valley and reaches the marshes only after passing the city. Its slope is so great that tide water reaches only to the Market St. bridge; so that the Brandywine has comparatively little share in the tidal volume of the whole system. Eastward from the junction of the two streams, in early colonial days, was an open anchorage.

Physical Conditions in Wilmington Harbor

The tidal range at the mouth of the Christiana River is about 6 ft., which formerly caused an enormous flow into the stream to fill the channel and cover the broad marshes stretching for many miles along the stream. On the falling tide the return of the waters to the channel from the marshes was so retarded by the vegetation, and the great dispersion of the waters over the marshes, that the ebb flow was prolonged; and the last of the ebb was very swift and powerful, scouring out the river bed and producing ample depths for navigation.

Today these conditions are changed. The open anchorage near the mouth of the river has filled up and is practically dry land. The city has extended to the south of the Christiana, reclaiming the land by filling and by excluding the tides with banks. A considerable part of the shore line is bulkheaded or revetted. Thus the tidal prism is now only a fraction of what it once was, and in addition several bridges restrict the channel to some extent, reducing the tidal range in the upper part of the river.

The result is a very great reduction in the tidal flow through the harbor and a great loss in the scouring power of the currents. It is probable that if natural forces were left to themselves under the present conditions, the harbor would shoal rapidly so that no vessel drawing more than 8 or 10 ft. could enter it and reach the wharves.

The very growth of the city, which has caused the deterioration of the harbor, demands that the harbor shall be kept open to commerce and at the same time justifies a considerable regular expenditure for that purpose. The problem is to do the work for the smallest expenditure possible compatible with an effective depth for navigation.

It has been determined that a mean-low-water depth of 21 ft. and a minimum width of 200 ft. are necessary for the proper use of the harbor for commerce. In 1896, when this project was first proposed, it was estimated that 1,400,000 cu.yd. of material would have to be removed to secure the proposed dimensions in the channel. Since that date, however, over 5,500,000 cu.yd. of material has been dredged. The excess over the estimated quantity is the amount deposited in the harbor by natural means. The amount dredged has averaged 260,000 cu. yd. annually, and comes from surface washings from the land throughout the watershed, from eroded banks, etc., and especially from the Delaware River whose waters are heavily charged with sediment at certain times of the year.

*Major, Corps of Engineers, U. S. A., Wilmington, Del.

If we could maintain the harbor by simply dredging out 260,000 cu.yd. a year, the problem would be an easy one; but this amount represents the actual shoaling during a time when the channel dimensions were much less than they are desired to be; and the enlargement of the channel bears a remarkable relation to the rate of shoaling.

A very slight checking of the current produces a comparatively great reduction in the silt-carrying power of the water. This will be seen at once when it is remembered that the carrying power varies with the sixth power

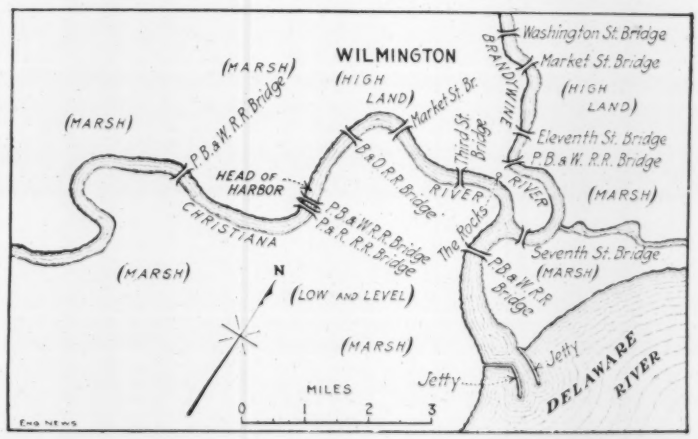


Fig. 1. Map of Wilmington Harbor, Delaware

of the velocity of the current. Thus a decrease in velocity of 1% produces a loss of carrying power of about 5%, while a loss in velocity of 5% produces a loss of about 46% in carrying power.

The velocity of the tidal currents in Wilmington harbor will be very materially checked by the proposed enlargement of the channel. Since the tidal prism of the harbor is the volume required to fill the harbor from the low-water level to the high-water level, it is not changed by dredging from the bottom of the channel, except in a small degree due to the slightly increased tidal range in the upper harbor caused by the freer flow of the tide in the enlarged channel. The total amount of tidal flow will not be materially increased and the tidal cycles, being controlled by those in the Delaware River, will require the same time as heretofore. Since we have about the same quantity of water flowing in the same time through a *larger* channel, the average velocity of flow will be correspondingly decreased.

From the above considerations and from the dredging records the writer estimates that when the channel has once been dredged to its full projected dimensions and is maintained, the rate of shoaling will be considerably over 400,000 cu.yd. annually.

Plans Proposed to Reduce the Rate of Silt Deposit

Various plans have been proposed to reduce the rate of deposit. Regulation works in the way of dikes and

training walls are chief among these. The progressive building of bulkheads, wharves, etc., for commerce will cause the confines of the harbor to approach the established harbor lines and will thus tend to produce the same effect as training walls built for that purpose alone. They will require no congressional appropriation and for that reason are preferable to special walls.

Training walls, however, have no effect on silt deposit during slack water. Their chief effect is to prevent sudden changes in the current velocity throughout the length of the channel, thus diminishing local shoaling; and since shoaling distributed over a large area is much harder to remove by dredging than the same amount of material assembled in a few localities, this property of training walls does not appeal very strongly to the practical mind.

The only way to stop the shoaling entirely is to keep the water moving at a sufficient velocity to prevent sedimentation, and this is clearly impracticable.

Regulating dikes intended to contract the ebb flow have been suggested as a means of increasing its velocity and scouring power so as to wash out the sediment deposited during the period of slack water. Such works, however, would restrict the flood currents as well as the ebb currents and reduce the tidal range in the upper river, so that the full effect expected during the ebb flow by advocates of the plan would not be realized.

In addition to this objection, it must be observed that the silt is deposited when the current is reduced below a certain velocity, but a restoration of that velocity will not pick it up again. Once deposited, the silt acquires considerable cohesion and cannot be picked up by any slight increase of velocity.

Impounding basins to retain a part of the tidal flow until late in the ebb and then let it go with a rush have been advocated. Such basins would necessarily occupy valuable space and would themselves be rapidly filled with sediment, as the conditions in them for settling would be ideal. It would probably require so great a rush of water to sweep out the harbor effectively that the shipping might join the sediment in a grand procession, and this might occur without that deliberation which is essential for passing drawbridges.

Harbor Maintenance by Dredging

All systems of improvement suggested with the idea of preventing or reducing silt deposit are found upon examination to require the assistance of dredging as the only certain means of positively removing the deposits which would still occur to some extent. Dredging, therefore, has been studied with a view to the possibility of maintaining the desired depth by that means alone, and this has been considered the most economical as well as the most satisfactory means available.

In many harbors, dredging involves the removal of a definite amount of material to obtain the desired channel, and thereafter, perhaps, occasional work to remove accidental deposits. But in Wilmington harbor a continuous deposit is in progress. The harbor can never be completed so as to require no further work. It must be continuously maintained.

We are accustomed to such conditions in many directions. For instance, cleanliness of person, home, premises, municipalities, etc., involves continuous removal of objectionable matter and we make the necessary effort or expend the required funds as a matter of course, provided the result in each case is thought to be worth the cost. Fortunately for Wilmington, the cost of continual dredging in the harbor is very small compared to the great value of the resulting commerce.

The above considerations lead us not to the final solution of the problem but merely to its beginning. It is still to be determined how the dredging can be accomplished best, and this question involves many factors.

Character of Material—The character of the material is of the utmost importance. It is almost entirely a very soft silt, readily cut from the bottom and raised to the surface of the water; but there presenting difficulties. If dredged in masses, as by means of a clamshell or dipper dredge, it can be placed in a scow very conveniently; but where and how can the scow be unloaded?

The mud cannot be dumped again into the river, for there is no place where it would not obstruct the harbor. Neither can it be dumped in the Delaware River, which presents a problem somewhat similar to that of the Christiana River but on a much greater scale. It cannot be placed ashore at a reasonable cost by mechanical means now available except by hydraulic dredging, and would require that it be dumped for rehandling, which is out of the question owing to the large proportion of the soft mud which would thus be allowed to return to the channel.

By far the best method of handling is by pumping the mud from the bottom directly ashore upon the neighboring marshes. The fluidity of the material after passing through the hydraulic dredge pump prevents its deposit in scows or bins on account of the time required for it to settle; but this same fluidity enables it to be forced through long pipes and distributed over the marshes where it fills all the small ditches and forms a nearly level and smooth surface.

Objections to Hydraulic Dredging—This has been the method employed heretofore, but it is becoming less and less applicable as the city grows and the marshes nearest the city are filled up and reclaimed. It has other disadvantages. For instance, a dredge moored in a channel only 200 ft. wide, with cables stretched out on both sides and a floating pipe-line connecting the vessel to one bank, presents a great obstruction to navigation.

Such a condition might be endured for a temporary job of short duration, but as a continuous performance it becomes absolutely intolerable. This objection applies to all types of plant that anchor in the narrow channel, especially when pipe-lines, pontoons, scows, tugs, moorings, etc., are used as auxiliaries.

Hydraulic pipe-line dredges possess the power of handling large quantities of material at very low cost when the material can be had fast enough without much shifting of position for the plant; but when the material is scattered and the pump cannot work to its full capacity and frequent shifting of the moorings and the shore pipe is necessary, the cost of the dredging runs up at a great rate. In dredging a channel with such plant, economy demands that the dredge shall move slowly and make a deep cut.

Channel Maintenance Problems—Let us suppose, however, that it is desired to maintain a channel in a harbor where continuous shoaling takes place uniformly throughout the harbor and that a dredge

of suitable capacity is used which removes the sediment just as fast as it it is deposited. Fig. 2 represents an ideal longitudinal section of the harbor from deep water to the head of navigation. The dredge starts at *A* and cuts the full cross-section as it goes. Deposit begins immediately behind the dredge. As the rates of dredging and deposit are assumed to be equal, we see that when the dredge has completed the cut to *B* the resulting bottom will be not as shown by the line *AB* but as shown by the line *aB*. It will be seen also that at no time will the depth available for navigation exceed the natural depth.

The cycle may be repeated as many times as desired without the slightest useful result to navigation, but to

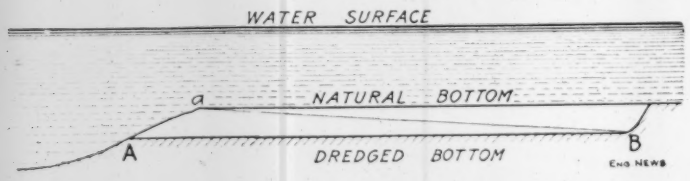


FIG. 2. DIAGRAM ILLUSTRATING SILT-REMOVAL PROBLEM IN WILMINGTON HARBOR

the great gain of the contractor who has an inexhaustible mine created for his sole benefit.

This illustration is roughly representative of the existing conditions at Wilmington, except that shoaling is not actually uniform throughout the harbor.

The dredging in recent years has been done by one of most efficient concerns in the United States and with excellent equipment. The unit price has been very low. The contractor has undoubtedly "made good," complying fully with the terms of his contracts, and it is without the slightest criticism of him that the conclusion is inevitably reached that, so far as attaining the projected depth in the harbor is concerned, the work has been a failure. A certain amount of relief has, however, been afforded to navigation because of late the dredging has been faster than deposit.

Under the last contract the harbor was dredged throughout to a depth of 18 ft. at mean-low-water and the greatest resulting navigable depth was 14 ft. The present contract is for dredging to the full projected depth depth of 21 ft., and an available depth as great as 18 ft. may result.

Returning to our illustration (Fig. 2), we see that if we replace the dredge by one of greater capacity we can cut through to *B* while the depth at *A* decreases by less than the depth of the cut. In other words, we can approach the projected depth throughout by increasing the capacity of the plant above the rate of shoaling; but dredging in this way we can never reach the full projected depth throughout and the nearer we approach it the more uneconomical becomes the dredging, because the dredge must make a shallow cut and keep shifting its position.

The only possible way in which the full projected depth can be maintained throughout is by dredging to a greater depth so that shoaling will proceed only far enough to begin to encroach upon the projected depth at *A* by the time the cut is completed to *B*. But we must not forget that, according to the principles we have already discussed, the rate of shoaling for an overdepth is certain to be greater than for the projected depth, and this in its turn increases the magnitude and cost of the improvement.

It is manifest that the quicker a cut can be made from *A* to *B* the less will be the shoaling during the cut. If a dredge of just sufficient capacity to remove the sediment as fast as it is deposited could be designed to work economically when making a *shallow* cut, then it could work more rapidly from *A* to *B* than a dredge of the same capacity making a deeper cut. The value of this may be seen from the following illustration:

Suppose the average annual shoaling amounts to 3 ft. (This rate is approximate to that at Wilmington harbor for the full depth of 21 ft.) If a dredge making a cut 3 ft. deep is used, dredging must be done to a depth of 24 ft. in order to maintain a depth of 21 ft. for navigation; but if the dredge can work at the same rate of output when cutting only 1 ft., then only a 22-ft. depth need be dredged.

The gain will be very great, for the rate of shoaling in a 22-ft. channel will be very much less than that in the 24-ft. channel, and a smaller and cheaper dredge of less capacity can keep pace with it. Further gains will be found in the flatter side slopes and the less depth to which water- and gas-mains and electric cables, which cross the river in considerable number, can be laid without interfering with the dredging and suffering damage.

TYPE OF DREDGE ADOPTED—A type of dredge has been adopted for Wilmington harbor which is intended to work without obstructing the channel more than other vessels of the same size. This is to be accomplished by working the dredging apparatus while the vessel moves along the channel. The material is to be pumped from the river bed and deposited in hoppers within the vessel, special appliances being provided to take this material in the form of a thick paste having very little water mixed with it.

Without these appliances the bins would be filled with a fluid containing little solid matter and dredging would have to cease as soon as the bins were filled, in order to prevent the escape of the silt with the overflow. Of course, sand or gravel would settle rapidly in the bins and the excess of water be wasted in the overflow, but with the silt of Wilmington harbor, once well diluted with water, settlement would hardly take place at all while the contents of the bins were agitated by continued pumping.

By constructing the special dredge, this difficulty can be reduced so as to make the dredging of the silt practicable at a reasonable cost. Once pumped into the bins, the silt will not be dumped into the river for rehandling but will be pumped directly ashore upon the marshes. This will be done wherever convenient and the only pipe-line needed will extend from the shore to the nearer edge of the channel, and no more space in the harbor will be taken up by the dredge while unloading than by any other vessel of the same size unloading or loading at a wharf.

The dredge will not be designed in detail by the United States Engineer Department, but competitive designs will be invited, the general requirements, dimensions, capacity and specifications for material and workmanship being stated in terms sufficiently exact to insure a first-class vessel, and to secure bids which may be intelligently compared, but so broad as to permit considerable latitude to the designer.

ADAPTABILITY OF THE FRUHLING TYPE OF DREDGE—It is expected that the accepted design will embody the well known advantages of the Frühling type of suction dredge,* as this appears to be the only type able to meet the specified requirements. In this type of dredge the suction head is dragged along the bottom from the stern at the desired depth very much as a giant hoe might be used to scrape the material from the river bed. The motion of the head, as the vessel moves forward, drives the scraped-up material into the hoe head, which is made hollow, where it is mixed with a suitable amount of water and is sucked up the hollow handle to the dredging pump within the vessel.

By keeping the head well filled with mud, the river water is excluded and the material flows to the pump nearly as thick as it lies in the river bed. Inlet jets at the cutter-head are the only source of dilution, and these are so controlled as to prevent an excess of water over that actually needed to make the mass flow.

This system of dredging is not applicable to material which is too hard or compact, but it is very efficient in removing silt for maintaining a channel already completed by dredges which are able to cut the hard bottom.

The cutter-head can be made from 8 to 16 ft. wide (in fact it is adjustable in width by adding or removing sections) and is thus able to develop the full capacity of the pump when making a broad, shallow cut. The shallower the cut, the faster the vessel moves ahead while dredging, thus fulfilling the requirements of the case as previously explained. A further advantage lies in the ability to re-dredge wherever needed to remove shoaling without waiting for the shoaling to proceed to a depth of several feet, as is necessary in order to use the ordinary type of suction dredge economically.

The hoppers or bins will have no doors or outlets through the bottom of the hull. Thus the only water to enter them will be that pumped in with the mud, and by skillful handling the bins can be filled with material containing a very large percentage of solid matter.

When the Frühling dredge "New Orleans" was tested before her departure for the mouth of the Mississippi River, she went to the entrance of Wilmington harbor and pumped up a couple of thousand yards of mud. In this material she made a remarkable showing, filling her hoppers with such a thick paste that a pailful dipped from the discharge and given ample time to settle showed no water on its surface, but remained just plain mud.

The expectation that in the same material a similar dredge can repeat this performance under like conditions seems reasonable.

The device for pumping the mud out of the hoppers consists of a system of valves and ducts by means of which the mud is led into the suction of the dredging pump and thence is forced ashore through a discharge pipe. To increase the distance to which the mud can be forced, as well as to assist it in flowing to the pump, sluices are provided which admit river water into the hoppers to the desired extent. Thus the dilution of the mud is under control, and the material may be delivered thick for making a solid fill or thin for spreading over an area.

A scow equipped for the purpose will construct temporary trestles for carrying the pipe-line ashore from the nearest navigable channel, so that provision can be made at several different places in order that the dredge may always have a pipe-line available to discharge her material. By this means it is expected to accomplish considerable reclamation of low land bordering on the river. The ability of the dredge to deliver the mud thick will avoid, in some cases, the need for special levees or banks to retain the fill and for sluices to drain off surplus water.

The method of employing this dredge will not be strictly as outlined in our illustration above, for the actual conditions differ from the ideal ones assumed. In practice, the shoaling will not be uniform throughout the harbor but will be most rapid at certain places where the current velocities are checked by the form of the channel or by some obstruction.

The greatest benefit to navigation can be secured by dredging each day wherever the depth in the channel is least. With a dredge of the type adopted, this can be easily managed. With the ordinary pipe-line plant, which has been the most efficient type heretofore available, it is quite impossible.

*Described in our issues of Mar. 5, 1908, p. 237, and Apr. 23, 1908, p. 466.

Baking Paint on Steel Passenger Cars is being tried experimentally by the Pennsylvania R.R., according to a paper by C. D. Young, engineer of tests, P. R.R., before a meeting of the American Society of Mechanical Engineers at New York City, Apr. 8. The gums and artificial driers, used in shortening the time of ordinary painting, continue their action so that the paints and varnishes increase in hardness and brittleness and more easily crack and chip—action which is aggravated by excessive expansion and contraction of the steel surfaces. Equipment painted by old methods, in service as little as four months had shown serious varnish cracks and chips on the interior surfaces.

Experiments were undertaken to secure a more elastic covering and this has finally resulted in the baking of the applied paint and varnish after its application. First a priming coat is given both exterior and interior of the car which is then run into the oven and baked for three hours at temperatures rising from 160 to 250°. Then the car is withdrawn and after being sufficiently cooled to work on, the surfaces are glazed and puttied. It then receives a first coat of surfacer and is again baked for three hours. Two or three additional coats of surfacer are applied as each case may require. After the last coat has been applied and baked, the outside surface of the car body is rubbed down with emery and oil to produce a flat and smooth surface. Then the various color coats are applied, tuscan red on the outside and green and bronze on the inside. Two coats are required for standard shades and each coat is baked. The car then is lettered and striped. Afterward the outside and inside surfaces get three coats of high-grade finishing varnish especially adapted for baking. Each coat is baked for three hours at temperatures rising from 120° to 150° F. Finally the interior surfaces are rubbed with pumice and oil to give a desired flat finish.

All the work noted, may be accomplished in six to eight days—a saving of about ten days over the old air-drying processes. Exact formulas for the mixtures can be obtained so that final uniformity is effected. The advantages of this system are: (1) Longer life of coating, (2) improved general appearance, (3) decreased cost of material, without increasing labor cost, (4) saving of shop time for cars, (5) complete sanitation of old cars. The disadvantages are in the initial cost of equipment and the operating cost of the oven.

The oven in use is 90 ft. 3 in. long, 13 ft. wide and 15 ft. high, and is housed in a light corrugated-iron building. The The framework is made up of 3-in. I-beams on 5-ft. centers. The roof frame is of the same sections and curved to conform closely to the car contours. Each end has two large doors which may be readily opened and closed. The whole oven is lined on the inside with ⅛-in. steel plate and on the outside with galvanized iron of 0.22-in. gage. The 3-in. interspace is filled with magnesia lagging and the doors are similarly insulated. Coils of steam pipe along the walls and manifold castings along the floor and close to the walls furnish 2000 sq.ft. of heating surface; steam at 100-lb. gage is used. Rectangular openings near the floor line admit the air necessary for circulation and four 8-in. ventilators are spaced at equal distances from the roof.

Depreciation and Public Service Regulation*

By Robert H. Whitten†

SYNOPSIS—A main theme discussed is whether in a rate-regulation proceeding there should be a deduction from cost-new on account of accrued depreciation due to age and wear and tear though such depreciation does not interfere with the present efficiency of the plant. Depreciation is concerned with the maintenance of the integrity of the investment at a uniform annual cost. The annual investment cost includes interest on investment and repairs and replacements. Tested by this rule the following methods are compared: (1) Straight-line method of estimating accrued depreciation and the annual depreciation allowance; (2) Straight-line method of fixing the annual depreciation allowance—accrued depreciation not deducted; (3) Sinking-fund method—no deduction from cost-new; (4) Uniform investment-charge method—accrued depreciation deducted from cost-new. The last method is approved. The same rule as to deduction for accrued depreciation and as to annual depreciation allowance is applicable in the case of a heretofore unregulated utility, as in the case of utility that has been subject to such regulation.

With the development during the past five years of control over the rates and service of public service companies, there is no problem that has been more puzzling than that of the proper treatment of depreciation. In order to determine just rates of charge it is usually necessary to determine accurately the cost of production, including in such cost both proper annual operating costs and a fair allowance for interest or profit on investment. The proper treatment of depreciation has been a chief source of contention both in the determination of the proper annual operating charges and in the fixing of investment cost upon which a return is to be allowed. The approval of a high annual allowance for depreciation may so increase operating expenses as to render impracticable a proposed reduction in rates. The finding of a large accrued depreciation may so reduce the investment cost as to allow a somewhat lower rate of charge than would otherwise be practicable. This being the case, it is natural that in a hotly contested case the energies of one side should be directed toward the seemingly contradictory ends of establishing a low annual allowance for depreciation and a large deduction for accrued depreciation, while the energies of the other side should be similarly directed toward a high annual allowance for depreciation and a small deduction for accrued depreciation. The entire problem is difficult and elusive but has been receiving the most careful and disinterested study of many students. It is clearly a problem in economics, with some ethical elements, and should be susceptible of fairly definite solution. Gradually the various factors of the problem are coming to light. There can of course be no real solution until all these factors are known and can be comprehended in their proper relation one to another.

*This study is in the main an elaboration of certain suggestions as to depreciation contained in the author's book on "Valuation of Public Service Corporations," reviewed in "Eng. News," Sept. 12, 1912.

†With New York Public Service Commission, First District, 154 Nassau St., New York City.

Some of the moot points at present are:

(1) Should the straight-line method or the sinking-fund method be used in computing (a) the annual depreciation allowance and (b) the accrued depreciation?

(2) What consideration should be given to probable or possible future obsolescence and inadequacy in computing (a) the annual depreciation allowance and (b) the accrued depreciation?

(3) Should anything be deducted from cost-new on account of accrued depreciation due to age and use though such depreciation does not interfere with the present efficiency of the plant?

This paper will be devoted chiefly to a consideration of this last point, though in its discussion the first point also will be briefly considered.

Objection to Deduction of Accrued Depreciation

The United States Supreme Court in Knoxville vs. Water Co., 212 U. S. 1, decided Jan. 4, 1909, has laid down in unequivocal terms the principle that there shall be a deduction from cost-new on account of accrued deterioration due to wear and age. W. H. Winslow called attention to what he considered the fallacy of this decision in a communication to the *Electrical World*, Feb. 25, 1909, p. 509. Mr. Winslow argues that while purchase value is affected by age and wear, rental value in the absence of decreased efficiency is not. He states that the decision is on a par with a rule that the wages of a servant should be diminished as his age increases unless he has been able to lay aside adequate provision for old age, even though age has not diminished the quality or the amount of the work he performs. He sums up his argument very cogently as follows:

I believe that failure to recognize the difference between sale and rental values, in public-utility cases, has been due to the false assumption that the purchaser at depreciated prices would need to consider only such prices in fixing rates of return, and that, therefore, there was no justice in allowing the owners to charge rates based on larger sums. This assumption fails to take into account the fact that the sum which must be accumulated for rebuilding is not the depreciated cost paid, but the original cost; and that, therefore, to escape loss, such a purchaser must either do one of two things: (1) At once place in a depreciation fund the difference beween the price paid and the cost of reproduction, new; or, (2) collect each year, in addition to the current depreciation, a further sum which will make up the past depreciation during the remaining life of the plant. In either case, in order to obtain the same net earnings, the rates charged must be equal to those charged on a new plant.

Mr. Winslow's argument evidently assumes the sinking-fund method of estimating the accrued depreciation and the annual allowance for depreciation. It is clear that if moneys in the depreciation reserve are assumed to accumulate at compound interest the annual payment into the fund cannot be considered an amortization of the investment. It does not return to the investor the money that he has put into the business. It earns not for the shareholder but for the depreciation fund. Under this theory, therefore, unless a company is allowed a return on cost-new, a certain portion of its property would seem to be confiscated for the benefit of the public. But under the sinking-fund theory, even if there is no fund in existence and the annual allowance that should have gone to the depreciation fund has actually been paid out in dividends, such amounts may possibly be considered not as a return of capital to the shareholder

but as payments that the shareholder holds in trust and must return with compound interest whenever they are needed for renewals or replacements.

STRAIGHT-LINE METHOD—ACCRUED DEPRECIATION DEDUCTED

Some authorities agree for the most part to the validity of the above reasoning, assuming the sinking-fund method, but deny that the sinking-fund method is a proper one to use for the purpose. Assuming the straight-line method of computing the accrued depreciation and the annual depreciation allowance, certain of the above difficulties are eliminated. Under this method it is not true that the investor will be compelled to accept a return on a smaller amount than he has actually invested without being reimbursed for such reduction in the amount of his principal. The straight-line method does not assume a payment in part but a payment in full. It is not a payment that is assumed to accumulate at compound interest but it is a payment that is assumed to cover the full amount of such depreciation. It may be invested in the business, thus reducing the amount that will need to be secured through the issue of stocks and bonds, or it may be returned to the shareholders and thus result in an actual or constructive reduction of the capital invested.

Let us assume a plant starting with an actual total capital investment of $1,000,000. This amount has covered the cost of land, structures and equipment, including promotion expenses and overhead charges and the necessary allowance for working capital. Assume that the annual depreciation on the depreciable property is estimated at 1½% on the total capital ($1,000,000). This estimate we will assume has been based on the probable efficient life and scrap value of the depreciable parts and verified by the actual experience of a long established plant of similar character. If 1½% on $1,000,000, or $15,000, is carried from revenue to depreciation reserve each year this reserve will be adequate to provide for renewals as they occur and in addition there will always be enough left to the credit of the depreciation reserve to make up the difference between the capital-cost and the capital-cost-less-depreciation.

Let us assume now that at the expiration of 20 years the amount in the depreciation reserve is $150,000 or 15% of the capital-cost. If the allowance of 1½% for depreciation was in fact a correct measure of the depreciation throughout this 20-year period, this $150,000 will exactly represent the difference between the original capital-cost and the original capital-cost-less-depreciation. If a business is experiencing a normal growth the most natural and profitable use that can be made of a depreciation reserve is to retain it in the business to meet the additional capital requirements for plant and working capital. We may assume, therefore, that this $150,000 will be invested in the business as additional capital outlay so that now the cost-new of the entire property is not $1,000,000 but $1,150,000. Of this amount $1,000,000 has been contributed by the shareholders and bondholders and the other $150,000 represents the depreciation reserve which is really the contribution of the consumers. If now in a rate-regulation proceeding the rate of return is based on $1,000,000 the investor will receive a return based on the full amount of all the capital he has ever contributed to the enterprise. This $1,000,000 is not cost-new but cost-less-depreciation. The depreciation amounts to $150,000 and the cost-new is $1,150,000. It seems clear that in this case cost-less-depreciation rather than cost-new is the fair value upon which the rate of return should be based.

James E. Allison, commissioner and chief engineer of the St. Louis Public Service Commission, in a valuable contribution to the study of this subject,* states that under certain conditions the accrued depreciation should not be deducted to obtain fair value. He apparently approves the straight-line method of fixing the annual allowance for depreciation. He states that "after depreciation charges have been established by legal regulation and are paid by the consumer, then for the future any accumulation which is or should be in the depreciation fund as a result of these charges is a repayment of investment by the consumer and should be deducted from gross value to determine the just amount upon which to base reasonable returns." But he states that it is not necessary that a company should have a depreciation fund equal to the amount of accrued depreciation indicated by the straight-line method. In large properties there is an approximately constant normal wear. The property is never brought back to new condition and there will consequently always be a constant theoretical depreciation that will not need to be offset by a depreciation reserve. He concludes (at p. 99):

> In a case of a heretofore unregulated property it cannot be shown that the company should have set aside depreciation charges to accumulate a fund equal to the Theoretical Depreciation, for such a fund would be needless. . . . .
>
> The conclusion seems clear then that in all ordinary cases of heretofore unregulated properties we cannot justly depreciate to obtain Fair Value unless we admit the justice of ex post facto laws or equivalent regulation, or unless we interpret Fair Value to mean Market Value and not Just Amount.

Depreciation is a problem in cost accounting. It is concerned with the allocation to each year's operating accounts of the waste in the instruments of production attributable to the year's operations. The cost of materials purchased and entirely consumed in the course of the year's operations is invariably included in ordinary operating expenses. The capital required to purchase and carry such materials during the turnover period is a part of the working capital. But some materials or instruments of production are not used up during the first year but have a life of 3, 10, 20, 50 or 100 years. They are consumed in operation just as surely as the former and constitute just as real a part of the cost of production. Their cost (exclusive of scrap value) must, however, be distrubuted over the full life period. The capital required to purchase and carry these long-lived consumable materials may also be considered a part of the working capital. It is this element of interest on capital that so greatly complicates the depreciation problem.

Cost-less-depreciation properly determined constitutes the real total *working* capital of the enterprise. It is the amount that under proper financial management the owners contribute to the enterprise. The depreciation reserve is properly speaking the contribution of the consumer and it directly reduces the amount of working capital that the owners must contribute to carry on the en-

*James E. Allison, "Should Public Service Properties be Depreciated to Obtain Fair Value in Rate or Regulation Cases?" Printed as Appendix A to the Report of St. Louis Public Service Commission on the United Railways Co. of St Louis, Sept. 11, 1912, pages 73-121.

terprise. Working capital in the narrow sense may be defined as the cost of stores and supplies on hand plus sufficient additional funds to bridge the gap between outlay and reimbursement. Working capital is not the full cost of labor, materials and supplies throughout the year but a balance of current outlay over reimbursement. Similarly, the *total working capital* of the physical plant may be conceived as the balance of outlay for plant over reimbursement through the depreciation reserve. It is cost-less-depreciation.

Uniform Annual Investment Cost Method

Depreciation is concerned with the maintenance of the integrity of the investment in depreciable property at a uniform annual cost. Such costs cannot be determined without some reference to interest on reserves and investment. The entire problem, therefore, may be simplified by considering depreciation as the adjustment necessary to secure a uniform investment cost. The supply of a public service must be considered a continuous process. Management or ownership may change but the plant and the service and the depreciation process are assumed to go on forever. The annual investment cost includes not only interest but also the repairs, renewals and replacements necessary to keep the property permanently in good working condition. The rights of the consumers using the supply at different periods demand that the annual charges attributed directly to the investment shall be as uniform as possible.

Disregarding for simplicity the element due to a possible fluctuation of the cost of repairs the above standard requires that the charge for interest plus depreciation per $1 of investment or cost-new shall be uniform. Cost-new is the factor that determines the capacity for production. If the percentage charge for interest plus depreciation per $1 of cost-new is made uniform, this part of the cost of production is most appropriately treated. Generally speaking, it seems fair that for each unit of total capacity there should be a uniform charge for interest and depreciation throughout the entire life of the utility. It may of course be urged that the aim should be not a uniform cost per unit of capacity or investment but a uniform cost per unit of product. This might have advantages but is impossible of practical application. Depreciation is an operating expense and like every other operating expense must be allocated to the year in which it actually accrues. It is true that a certain equalization of the per unit cost of output may be brought about through some method of capitalizing or reimbursing the cost of establishing the business. This, however, should be through an entirely distinct accounting process. Correct accounting requires that all operating expense, including depreciation, should be correctly stated in each year's accounts. There is one way, however, in which output may have a very direct bearing on depreciation. The life of a car wheel is properly measured in car miles rather than in years. The annual depreciation therefore depends on the number of car miles run. With the development of the traffic of a railway the annual depreciation on car wheels increases. This is also true of other items, such as rails. It is not true in any great measure, however, of a large proportion of the depreciable property of a public utility. Wear is substantially constant, or use and chance are controlling in fixing the probable life.

Comparison of Chief Methods

As a problem in cost accounting the accrued depreciation and the annual allowance for depreciation are interdependent. Our theory in regard to an annual allowance for depreciation will necessarily control that in relation to the amount of accrued depreciation and *vice versa*. The amount of the accrued depreciation depends on the method adopted for computing the annual payment to the depreciation reserve. If the straight-line method is used the accrued depreciation will be greater, as will also the annual payment out of revenue to the depreciation reserve. If the sinking-fund method is used the accrued depreciation will be smaller, as will also the annual allowance for depreciation.

In the following discussion the chief methods of allowing for annual depreciation and of fixing the amount, if any, of accrued depreciation to be deducted in fixing fair value for rate purposes, are examined with special reference to their conformity to the principle above discussed of a uniform annual investment charge, i. e., a uniform percentage on cost-new to cover both interest and depreciation. In order to test such conformity it is necessary to show the combined percentage for interest and depreciation throughout the life of a utility. But the lives of various utilities even of the same general class show very different records as to the amount of accrued depreciation. We know, however, that there is a tendency for all utilities to settle down after a time to a more or less uniform condition as regards the percentage amount of accrued depreciation and the annual requirements for renewals and replacements. After the various parts of a large public-utility plant have gone through complete cycles of renewals the plant settles down to a condition in which, except for extraordinary functional depreciation, expenditures for maintenance, repairs and renewals become practically constant. There is little fluctuation from year to year and the averages by five- or ten-year periods are practically identical. This settling down or equalizing process is very greatly hastened by the fact that all large systems are constructed by piecemeal.

Tables I to IV, used in comparing the different methods of depreciation, are based on the theory that the plant is built up piecemeal. By assuming that the additions to the plant are uniform in amount and come at uniform intervals and by assuming a uniform life for all such additions, the process by which a plant settles down to uniform condition can be approximately shown, as well as the condition as to accrued depreciation and the requirements for renewals after the plant has thus settled down.*

1. *Straight-line method of estimating accrued depreciation and the annual depreciation allowance.—Accrued depreciation deducted from cost-new in fixing fair value for rate purposes.* Under this method the combined percentage charge for interest and depreciation declines with the accruing depreciation until the plant settles down to a uniform amount of normal wear. Under the conditions assumed in Table I there is at the start a combined percentage charge of 8½% on cost-new (6% for interest and 2½% for depreciation). The percentage for depreciation remains uniform but with the accruing depreciation the 6% interest charge based on

*This method of illustration has been worked out by James E. Allison, in the report (pp. 73-121) mentioned in an earlier foot note.

cost-less-depreciation becomes a smaller and smaller percentage on cost-new until when the plant is settled down to permanent condition it is but 4½% on cost-new and the combined percentage for interest and depreciation is 7% on cost-new as against 8½% at the start. This appears to throw an undue burden upon the early years.

TABLE I. STRAIGHT-LINE METHOD—ACCRUED DEPRECIATION DEDUCTED FROM COST-NEW

Assumed conditions:
1. Non-depreciable property (including scrap value of depreciable property) equals 50% of cost-new.
2. Plant built piecemeal in 20 even annual increments of $10,000 each.
3. Life of each annual cost increment (obsolescence, inadequacy and casualty not considered) 20 years.
4. Fair rate of return 6% on cost-less-depreciation.
5. Annual straight-line ordinary physical depreciation 5% on depreciable property or 2½% on total cost-new.
6. Depreciation reserve invested in business, thus reducing the necessary contribution from the sale of stock and bonds.

			Annual return: 6% on cost-less-	Annual depreciation: 2½% on cost-	Return plus annual depreciation		Accrued depreciation	
Year	Cost-new	Cost-less-depreciation	depreciation	new	Amount (col. 4+5)	Per-cent. on cost-new	Amount	Per-cent. of cost-new
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1	$10,000	$10,000	$600	$250	$850	8.500	$250	2.50
2	20,000	19,750	1185	500	1,685	8.425	750	3.75
3	30,000	29,250	1755	750	2,505	8.350	1,500	5.00
4	40,000	38,500	2310	1000	3,310	8.275	2,500	6.25
5	50,000	47,500	2850	1250	4,100	8.200	3,750	7.50
6	60,000	56,250	3375	1500	4,875	8.125	5,250	8.75
7	70,000	64,750	3885	1750	5,635	8.050	7,000	10.00
8	80,000	73,000	4380	2000	6,380	7.975	9,000	11.25
9	90,000	81,000	4860	2250	7,110	7.900	11,250	12.50
10	100,000	88,750	5325	2500	7,825	7.825	13,750	13.75
11	110,000	96,250	5775	2750	8,525	7.750	16,500	15.00
12	120,000	103,500	6210	3000	9,210	7.675	19,500	16.25
13	130,000	110,500	6630	3250	9,880	7.600	22,750	17.50
14	140,000	117,250	7035	3500	10,535	7.525	26,250	18.75
15	150,000	123,750	7425	3750	11,175	7.450	30,000	20.00
16	160,000	130,000	7800	4000	11,800	7.375	34,000	21.25
17	170,000	136,000	7160	4250	12,410	7.300	38,250	22.50
18	180,000	141,750	8505	4500	13,005	7.225	42,750	23.75
19	190,000	147,250	8835	4750	13,585	7.150	47,500	25.00
20	200,000	152,500	9150	5000	14,150	7.075	47,500	23.75
21	200,000	152,500	9150	5000	14,150	7.075	47,500	23.75
22	200,000	152,500	9150	5000	14,150	7.075	47,500	23.75
23	200,000	152,500	9150	5000	14,150	7.075	47,500	23.75

2. *Straight-line method of fixing the annual depreciation allowance—Accrued depreciation not deducted in fixing fair value for rate purposes.* It is apparent that in a new plant the requirements for renewals and replacements are much less in the early years than they are later when the plant has settled down to a substantially uniform condition as to average age and wear of its various parts. If an allowance for depreciation on the straight-line basis is made from the start, a large depreciation reserve will be accumulated that will never be actually needed for renewals or replacements. This reserve will represent the difference between cost-new and cost-less-depreciation, but as the plant as a whole can never be brought back to new condition this reserve will never be drawn upon. If this is true it is argued that it is foolish to provide such a reserve. The depreciation allowance of the early years should be reduced to the amount necessary to meet actual renewals and replacements during the period while the plant is settling down. When the plant has finally settled down to a uniform condition as to average age and wear then only will the full depreciation allowance on the straight-line basis be requisite. This method will relieve the operating expenses of the earlier years. It is assumed that the consumer will secure the benefit of this reduced expense either in lower rates of charge during such early years or in a lower development expense to be reimbursed out of future earnings. It follows naturally from this method that there should be no deduction for accrued depreciation in fixing fair value for rate purposes. Since under this theory the accrued depreciation is not amortized and not placed in a reserve and devoted to the capital purposes of the enterprise, the full cost-new represents the real sacrifice of the owners and constitutes the most natural base on which to compute a fair return.

This plan, however, shows up badly under the test of a uniform combined percentage charge for interest and depreciation. Under the conditions assumed in Table II the combined percentage charge increases from 6% on cost-new to 8½% on cost-new. If a higher rate of straight-line depreciation were assumed, the difference would be even greater and might even amount to a doubling of annual combined charge for interest and depreciation. Assuming a uniform output per $1 of investment this would mean that rates of charge would have to be largely increased. Interest is the investment carrying charge. Depreciation is the charge required to keep the investment intact. Together they constitute the total investment carrying charge.

TABLE II. STRAIGHT-LINE METHOD—NO DEDUCTION FROM COST-NEW

Assumed conditions:
1-3. Same as in Table I.
4. Fair rate of return 6% on cost-new.
5. Same as in Table I, except that no allowance is made for annual depreciation until actually required for renewals in the twentieth year.

Year	Cost-new	Annual return: 6% on cost-new	Annual depreciation: 2½% cost-new	Return plus annual depreciation: % on cost-new
1	$10,000	$600	....	6
2	20,000	1,200	....	6
3	30,000	1,800	....	6
4	40,000	2,400	....	6
5	50,000	3,000	....	6
6	60,000	3,600	....	6
7	70,000	4,200	....	6
8	80,000	4,800	....	6
9	90,000	5,400	....	6
10	100,000	6,000	....	6
11	110,000	6,600	....	6
12	120,000	7,200	....	6
13	130,000	7,800	....	6
14	140,000	8,400	....	6
15	150,000	9,000	....	6
16	160,000	9,600	....	6
17	170,000	10,200	....	6
18	180,000	10,800	....	6
19	190,000	11,400	....	6
20	200,000	12,000	5000	8½
21	200,000	12,000	5000	8½
22	200,000	12,000	5000	8½
23	200,000	12,000	5000	8½

3. *Sinking-fund method—No deduction from cost-new.* For present purposes we may at once rule out the application of a sinking-fund method of estimating depreciation that would include a deduction of the accrued depreciation from cost-new in fixing fair value for rate purposes. We are trying now to find a plan that if applied to a public utility from the start would be suited to its purpose and equitable both to the public and to the company. It needs no extended argument to demonstrate that if the moneys paid into the depreciation reserve are assumed to accumulate at compound interest for the sole benefit of the depreciation reserve, they do not constitute a return to the owner of any part of his original investment. Unless, therefore, he is allowed to earn a return on cost-new, a part of his actual investment is confiscated.

Under the conditions assumed in Table III the sinking-fund method with no deduction for accrued depreciation shows a uniform combined annual charge for interest and depreciation of 7.68%. This method appears to conform exactly to our uniform-annual-investment-charge standard. There are, however, serious objections to the sinking-fund method of allowing for depreciation. It is assumed that a fund is set aside and made to accumulate at a prescribed rate of interest. Presumably it is to be invested in outside securities and kept as an entirely distinct fund. The assumption of a separate fund greatly complicates the accounts. It is usually merely an assumption both as to its existence and as to the rate at

which it accumulates. Business practice recognizes that ordinarily the most natural, the most secure and the most profitable use that can be made of a depreciation reserve is to retain it in the business to meet the additional capital requirements for plant and working capital. Fundamentally the depreciation reserve is a part of the entire capital needed to carry on the enterprise. There is no reason why a part of the total capital should be set apart and assumed to accumulate at a rate different from that earned on the entire investment. The entire enterprise is a unit and the profits, whatever they may be, are the earnings of the entire investment. One part of the investment should not be assumed to earn at an arbitrary rate and the rest at a different rate.

The investment of depreciation reserves as separate and distinct funds is liable to abuse in public-utility enterprises. Such funds may be invested in doubtful securities or used to further the private financial schemes of the directors. They may be used by the holding company to invest in other public-utility enterprises and may be made to earn for the holding company not 3% or 4% but 6% or 8%. If the 6% or 8% could have been earned by reinvesting in the business of the utility for which the reserve was created, the consumers of that utility have lost heavily by this method of financing.

The depreciation reserve is built up during the early years of the enterprise. It is during such earlier years that the payments into the depreciation reserve are normally greater than the annual expenditures for renewal. When a utility has settled down to a constant average of wear and age, the annual allowance for depreciation is, under the straight-line method, about equal to the annual expenditures for renewal, and, under the sinking-fund method, much less than such annual expenditures. As almost every utility is built somewhat on the piecemeal plan and as it particularly is true that there are normally a considerable number of additions to capital during the first twenty years of an enterprise, there would seem to be abundant opportunity for the investment of the entire depreciation reserve in such additions. It is also to be noted that a large part of this reserve may be invested *permanently* in the business. When a utility has settled down to a constant average of wear and age, the depreciation reserve remains at a constant percentage of cost-new. It is particularly appropriate, therefore, that this permanent reserve should be permanently invested in the business. And if this is done why should it be assumed to be earning for a depreciation fund at the rate of 4% while the business as a whole is earning 6%?

4. *Uniform investment-charge method—Accrued depreciation deducted from cost-new.* The uniform investment-charge method takes account of the fact that ordinarily the safest and best use that can be made of a depreciation reserve is to invest it in the business; that the reserve, therefore, becomes an integral part of the entire business and cannot be assumed to earn at a different rate from that of the business as a whole; that the expenditures for renewals in the earlier years are much less than later when the *average* age of the various units constituting the plant is at a maximum; that the depreciation reserve is for the most part accumulated from the excess of the depreciation allowance over the actual renewals during the earlier years; that investment of the reserve in the business decreases the amount of capital to be furnished by the owners and correspondingly decreases the percentage return *as based on cost-new.*

With a declining percentage return as based on cost-new the only way to secure a uniform combined annual charge for interest and depreciation is to so adjust the depreciation allowance that the increase in percentage charge for depreciation based on cost-new will exactly offset the decline in the percentage return.

TABLE III. SINKING-FUND METHOD—NO DEDUCTION FROM COST-NEW

Assumed conditions:
1-3. Same as in Table I.
4. Fair rate of return 6% on cost-new.
5. Annual allowance for ordinary physical depreciation on 4% sinking-fund basis, 3.358175% on depreciable property or 1.679087% on total cost-new.

Year	Cost-new	Annual return: 6% on cost-new	Annual depreciation allowance: 1.679087% on cost-new	4% interest on depreciation reserve	Accrued depreciation Amount	Accrued depreciation % of cost-new
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	$10,000	$600	$167.91	$0.00	$167.91	1.679
2	20,000	1,200	335.82	6.72	510.45	2.552
3	30,000	1,800	503.73	20.42	1,034.60	3.449
4	40,000	2,400	671.63	41.38	1,747.61	4.369
5	50,000	3,000	839.54	69.90	2,657.05	5.314
6	60,000	3,600	1007.45	106.28	3,770.78	6.285
7	70,000	4,200	1175.36	150.83	5,096.97	7.281
8	70,000	4,800	1343.27	203.88	6,644.12	8.305
9	90,000	5,400	1511.18	265.76	8,421.06	9.357
10	100,000	6,000	1679.09	336.84	10,436.99	10.437
11	110,000	6,600	1847.00	417.48	12,701.47	11.547
12	120,000	7,200	2014.90	508.06	15,224.43	12.687
13	130,000	7,800	2182.81	608.98	18,016.22	13.859
14	140,000	8,400	2350.72	720.65	21,087.59	15.062
15	150,000	9,000	2518.63	843.50	24,449.72	16.300
16	160,000	9,600	2686.54	977.99	28,114.25	17.571
17	170,000	10,200	2854.45	1124.57	32,093.27	18.878
18	180,000	10,800	3022.36	1283.73	36,399.36	20.222
19	190,000	11,400	3190.27	1455.97	41,045.60	21.603
20	200,000	12,000	3358.18	1641.82	41,045.60	20.523
21	200,000	12,000	3358.18	1641.82	41,045.60	20.523
22	200,000	12,000	3358.18	1641.82	41,045.60	20.523
23	200,000	12,000	3358.18	1641.82	41,045.60	20.523

Table IV shows a theoretical application of the uniform-investment-charge method. Under the assumed conditions a uniform annual charge of 7.36% on cost-new is adequate for interest and depreciation. The return is 6% on cost-less-depreciation as cost-less-depreciation is the amount that under the assumed conditions has been secured from the issue of stock and bonds. The annual allowance for depreciation is the difference between this uniform annual charge of 7.36% and the amount required to pay 6% interest on cost-less-depreciation. The depreciation allowance increases in amount

TABLE IV. UNIFORM-INVESTMENT-CHARGE METHOD—ACCRUED DEPRECIATION DEDUCTED FROM COST-NEW

Assumed conditions:
1-4. Same as in Table I.
5. Annual sinking-fund contribution compounded at 6% to equal 50% of cost-new in 20 years, 1.35923% on cost-new.
6. Depreciation reserve invested in business, thus reducing the necessary contribution from the sale of stock and bonds.

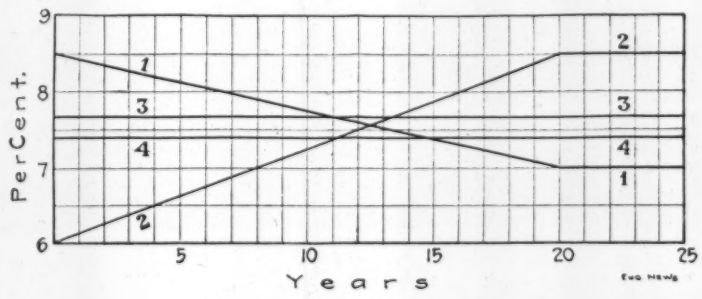
Year	Cost-new	Cost-less-depreciation	Return plus annual depreciation: 7.35923% on cost-new	Annual return: 6% on cost-less-depreciation	Annual depreciation (col. 4 less 5)	Accrued depreciation Amount	Accrued depreciation % of cost-new
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	$10,000	$10,000.00	$735.92	$600.00	$135.92	$135.92	1.359
2	20,000	19,864.08	1,471.85	1191.84	280.01	415.93	2.080
3	30,000	29,584.07	2,207.77	1775.04	432.73	848.66	2.829
4	40,000	39,151.34	2,943.69	2349.08	594.61	1,443.27	3.608
5	50,000	48,556.73	3,679.61	2913.40	766.21	2,209.48	4.419
6	60,000	57,790.52	4,415.54	3467.43	948.11	3,157.59	5.263
7	70,000	66,842.41	5,151.46	4010.54	1140.92	4,298.51	6.141
8	80,000	75,701.49	5,887.38	4542.09	1345.29	5,643.80	7.055
9	90,000	84,356.20	6,623.31	5061.37	1561.94	7,205.74	8.006
10	100,000	92,794.26	7,359.23	5567.66	1791.57	8,997.31	8.997
11	110,000	101,002.69	8,095.15	6060.16	2034.99	11,032.30	10.029
12	120,000	108,967.70	8,831.07	6538.06	2293.02	13,325.32	11.104
13	130,000	116,674.68	9,567.00	7000.48	2566.52	15,891.84	12.224
14	140,000	124,108.16	10,302.92	7446.49	2856.43	18,748.27	13.392
15	150,000	131,251.73	11,038.84	7875.10	3163.74	21,912.01	14.608
16	160,000	138,087.99	11,774.77	8285.28	3489.49	25,401.50	15.876
17	170,000	144,598.50	12,510.69	8675.91	3834.78	29,236.28	17.198
18	180,000	150,763.72	13,246.61	9045.82	4200.79	33,437.07	18.576
19	190,000	156,562.93	13,982.54	9393.78	4588.76	38,025.83	20.014
20	200,000	161,974.17	14,718.46	9718.45	5000.01	38,025.88	19.013
21	200,000	161,974.34	14,718.46	9718.46	5000.00	38,025.66	19.013
22	200,000	161,974.34	14,718.46	9718.46	5000.00	38,025.66	19.013
23	200,000	161,974.34	14,718.46	9718.46	5000.00	38,025.66	19.013

and in per cent. of cost-new each year until in the twentieth year when the plant has settled down to a uniform accrued depreciation of 19% and to a uniform requirement for renewals of $5000, or 2½% on new-cost, the depreciation allowance exactly meets this requirement.

In order to determine the percentage on cost-new that will provide a uniform annual charge for return plus depreciation, add to the fair rate of return the per cent. on cost-new that set aside annually and compounded at the same rate of interest as the fair rate of return, will within the equated life of the depreciable property exactly equal the cost-new of such depreciable property. In Table IV the fair rate of return is 6%, and 1.36% on cost-new compounded at 6% will in 20 years exactly equal $5,000. The depreciable property amounts to 50% of the cost-new, so that $5000, the assumed accumulation of the sinking-fund, is exactly equal to the depreciable part of the initial investment of $10,000.

Conversely to find the accrued depreciation in an existing plant under the uniform-annual-investment-charge method, find the amount that should be in the depreciation reserve assuming that the annual depreciation allowance had been set aside from the initiation of the enterprise in accordance with the method above described.

The accompanying diagram is a graphical comparison of the combined percentage for interest and depreciation



(1) Straight-line depreciation; accrued depreciation deducted from cost-new (Table I).
(2) Straight-line depreciation; no deduction from cost-new (Table II, modified).
(3) Sinking-fund depreciation; no deduction from cost-new (Table III).
(4) Uniform investment charge method; accrued depreciation deducted from cost-new (Table IV).

DIAGRAM OF COMBINED INTEREST AND DEPRECIATION PERCENTAGE UNDER EACH METHOD

under each of the four methods of depreciation illustrated in Tables I-IV. The straight-line method with a deduction of accrued depreciation starts with the highest percentage but has the lowest permanent combined percentage. Straight-line depreciation with no deduction for accrued depreciation starts with the lowest percentage but has the highest permanent percentage. The sinking-fund method with no deduction for accrued depreciation has a uniform continuous percentage which is about midway between the permanent percentages under the two straight-line methods. The uniform-investment-charge method has a uniform percentage somewhat lower than the sinking-fund method. It would be identical with that of the sinking-fund method if the sinking-fund were assumed to accumulate at the same interest rate as the rate of return, which in this case is 6%. The uniform-investment-charge method, however, has manifest advantages from an accounting and practical business standpoint.

APPLICATION TO HERETOFORE UNREGULATED UTILITY

Assuming the adoption of the uniform-annual-investment-charge method, the straight-line method or the sinking-fund method as the proper method for the treatment of depreciation as regards a new enterprise or as regards the future of an existing enterprise, is it necessary to qualify such method as regards assumptions as to the past of a company that has heretofore not been subject to regulation? Can we assume that the theory that we apply to the future has been in operation since the initiation of the enterprise? If we determine that the sinking-fund method is upon the whole most just and practicable, can we assume that a fund has been accumulating on this basis and is now earning interest and that the amount of such interest may be deducted from the annual allowance that would otherwise be required to meet current renewals? Or if we adopt the uniform-annual-investment-charge method, can we assume that the depreciation reserve is equal to the amount that it should have reached had this method been applied from the initiation of the enterprise and that therefore, it is just to deduct this amount from cost-new to determine fair value for rate purposes? It seems that both these questions must be answered in the affirmative. There is no question that depreciation is an operating expense. There is no question but that it is an expense that must by some method be apportioned over the entire life of the depreciable property. There is no way that this can be done except by apportioning a fair share of the burden to the operating expenses of each year since the initiation of the enterprise. To be sure there may be cases where the past profits of an enterprise have been insufficient to pay a fair rate of return and at the same time set aside a proper depreciation reserve. The situation may demand that in prescribing regulations for the future the company be allowed to reimburse out of the earnings the amounts by which past earnings have failed to provide an amount adequate to pay operating expenses including depreciation and a fair return on the investment. It is important to note that this shortage is properly treated as a deficit to be reimbursed and not as additional outlay to be capitalized.

❖

Municipal Ownership of all local public utilities and of a short railway line as well is the proud boast of Guelph, Ont. Guelph is a city of 15,148 population (in 1911), located 48 miles west of Toronto. The city claims to be the first Canadian municipality to own and operate successfully all of its public utilities. These are managed by commissions. A small water-works plant was established in 1878, and has since been extended. Some years ago the city bought an electric street railway system, built by an individual who had not been able to make it pay. The city paid $78,000 for the system, including the franchise, and has since extended it, so that at present, with equipment, it represents $135,000. It is stated that the street railway has paid since the city took it over. The fare with transfers is 3c. The gas and electric-light works were bought by the city a few years ago at a cost of $155,000, and have been extended since then. Gas is sold to large consumers at 80c. per cu.ft., to consumers of medium amounts at 85c., and to small consumers at 90c. In 1907 the city secured hydro-electric power from Niagara Falls. It sells electric-light and current at the rate of 6c per 1000 watts. The city owns the Guelph Junction Ry., 15 miles in length, and leases it to the Canadian Pacific on a percentage basis. The city has sewerage systems, a system of garbage disposal, eight parks spreading over 100 acres in area, and three river-rowing courses. In order to make its advantages known, the city has an industrial department. R. McDonald is Industrial Commissioner, and to him we are indebted for the information given in the foregoing sentences.

A Test of Red-Lead Priming Paints

By Cloyd M. Chapman*

The use of red lead as a priming coat for structural steel has been common for a great many years. The popularity of this pigment for use in paint and particularly as a priming or shop coat seems amply justified by the good record it has usually made for itself.

Fillers in Red-Lead Paints

For many years it was the almost universal custom, when red lead was used, to mix the dry powdered pigment with the vehicle on the job as wanted, for the very good reason that if the lead and oil were mixed in advance and allowed to stand the lead would rapidly settle and gradually harden in the bottom of the package. The settling and hardening process continued to a point where it was very difficult or quite impossible to mix the paint again for use. This troublesome characteristic of the pigment makes it practically a necessity, where straight red lead and oil are to be used, that the mixing be done at or near the point of application and not long before the paint is to be used.

This made it almost impossible for the makers of ready-mixed paints to furnish a red-lead product which would pass the specifications of a "pure red-lead and oil paint." The result has been that ready-mixed products have for many years been on the market which contain in addition to the red lead a "filler" or "suspender" such as china clay, silica, chalk, or asbestine, as a means of retarding or preventing the settlement and hardening of the lead. The addition of these fillers or suspenders has accomplished the desired result as regards the settling and hardening, and has also materially reduced the cost of manufacture of ready-mixed red-lead paints.

Effect of Fillers

As far as the effect that these added materials have upon the wearing and protective qualities of the paint is concerned, there seems to be an honest difference of opinion even among those well qualified to judge. There is no doubt that pure red lead and oil make a good protective priming coat for structural steel. There is equally no doubt that china clay, silica, chalk, and asbestine, with oil, make much poorer coatings for the same purpose. It is claimed, however, by the advocates of ready-mixed red-lead paints, that the addition to red lead of a sufficient quantity of one or more of these fillers or suspenders does not reduce the protective or wearing qualities of the paint.

Tests of Paints with Fillers

In order to gather further information on this question for guidance in specifying the paint to be used on the steel going into the various construction work in their charge, Westinghouse, Church, Kerr & Co. have made an extended series of tests of both ready-mixed and straight red-lead paints. These tests were made in connection with and as a part of the very extensive line of paint tests made by this company, and described in detail in the proceedings of the American Society for Testing Materials for 1910† and 1911.

*Engineer in charge, Westinghouse, Church, Kerr & Co., 37 Wall St., New York City.

†"Engineering News," Aug. 18, 1910, p. 178.

The method of testing, briefly outlined, was as follows:

Samples of the ready-mixed red-lead paints were secured from paint manufacturers, and samples of dry red lead from pigment manufacturers. Plates of mild steel of uniform size and shape were pickled in sulphuric acid to remove the mill scale, cleaned and numbered. In the case of the ready-mixed paints they were applied to the plates as received, after thorough mixing. In the case of the dry pigments they were mixed with pure raw linseed oil shortly before applying.

As red lead is considered most effective when used as a priming coat only, or with an outer or finishing coat of some other paint over it, these tests were made with the red-lead paint applied directly to the metal and with a second coat of another kind of paint applied over it. Inasmuch as the durability and protective qualities of the two-paint combinations might be more or less affected by the second coat it was thought inadvisable to select any one class of paint for this use. Instead of using one paint for second coat, four varieties were applied over each red-lead primer. The four second coaters chosen were: Iron oxide, artificial graphite, carbon,

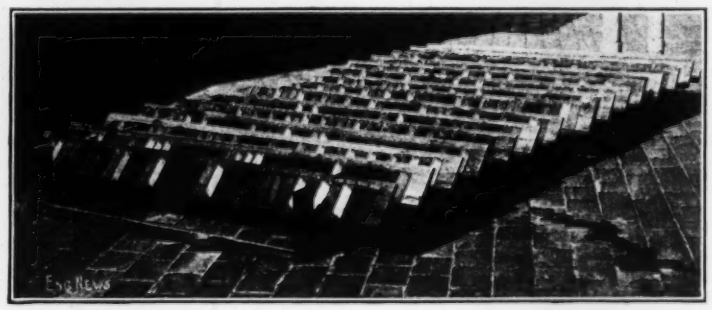


Fig. 1. Exposure-Test Rack on Roof of Maritime Bldg., New York City

and a tar product. These paints, with the exception of the tar paint, were prepared in the laboratory by grinding the dry pigments in pure raw linseed oil to a stiff paste and thinning as used with raw linseed oil to which has been added about 6% of turpentine linoleate dryer. In the case of the carbon paint a somewhat higher percentage of dryer was used.

The pigments used for second-coat paints were all of well known standard brands. They were mixed with the oil in such proportions as to give a paint of full, even, smooth-flowing consistency with good body. The tar product was a medium-priced black paint of fair quality. When tested alone, i.e., without a red-lead or other primer, it showed very fair protective qualities for this class of paint.

Six steel plates were used for each red-lead paint tested: One of these plates was given only one coat of the red-lead paint; a second plate was given two coats; the remaining four plates were each given a first or priming coat of the red-lead paint and a second coat of one of the four kinds of paint mentioned above.

Sufficient time was allowed between coats for thorough drying. Great care was taken to insure uniform brushing and even thickness of coats on the plates. All painting was done by one person experienced in this line of work.

After the second coats had thoroughly dried the plates were exposed to the weather on the roof of the Maritime

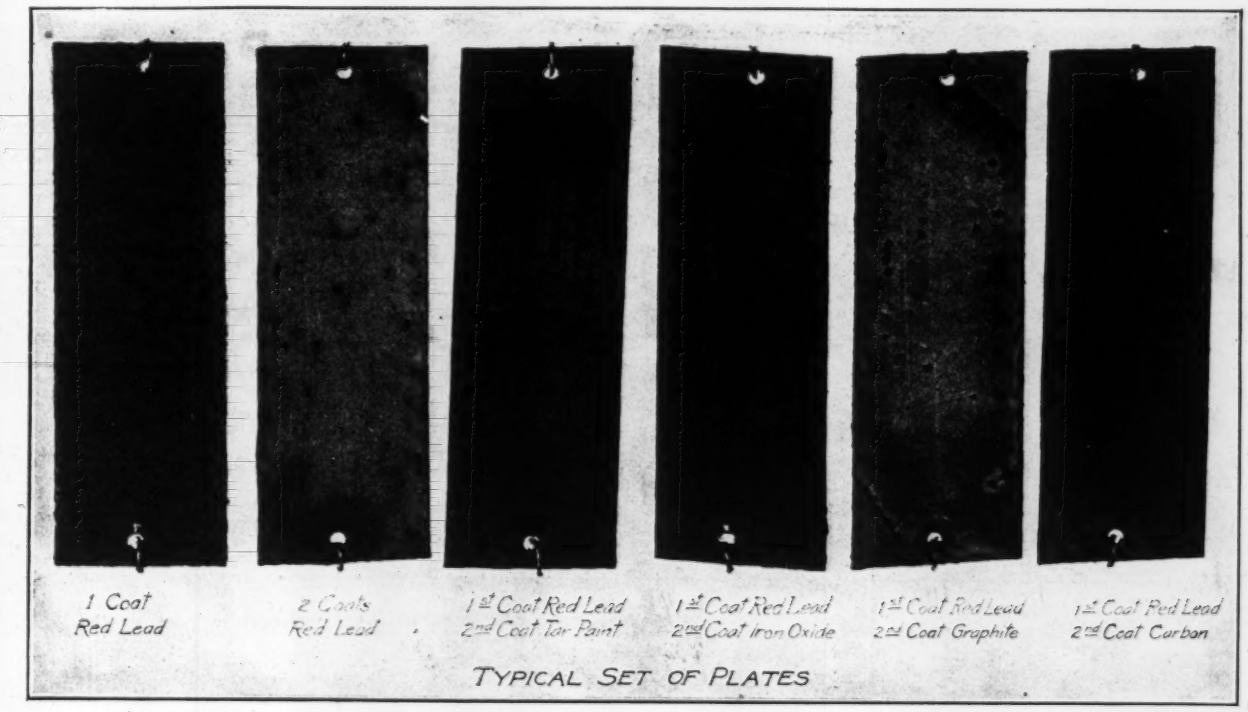

1 Coat Red Lead
2 Coats Red Lead
1st Coat Red Lead 2nd Coat Tar Paint
1st Coat Red Lead 2nd Coat Iron Oxide
1st Coat Red Lead 2nd Coat Graphite
1st Coat Red Lead 2nd Coat Carbon
TYPICAL SET OF PLATES

FIG. 2. TYPICAL SET OF PLATES WITH PRIMER ALONE AND WITH PRIMER COVERED BY SECOND COAT

Building on the southern extremity of Manhattan. Fig. 1 shows the method of exposing the test plates. Examinations of the plates were made at regular intervals of three months, and a record made of the condition of each plate at each inspection. Fig. 2 shows a set of six plates which are fairly representative of the present condition of the test plates.

Some 53 red-lead paints were tested, making a total of 318 plates. Of these 53 paints, 42 were ready-mixed samples submitted by the makers, and the remaining 11 were mixed from the dry pigment in the laboratory. There were also tested 8 samples of litharge paints for comparison with the red leads.

Another feature which also received attention was the relative effect of asbestine and china clay, when mixed with red lead to keep it in suspension, upon the protective value of the lead. The asbestine and china clay were added to the red-lead paints in two ways: As a dry powder added to the dry red lead and then mixed with the oil, and as a pulp or paste added to the red-lead paint after they had first been ground in oil and stood as a paste a considerable length of time. They were added in two proportions: 3½ parts by weight of red lead to one part by weight of the suspender (which is about equal parts by volume), and one part of red lead to one part of the suspender by weight.

Tests were also made of the four second-coat paints by themselves, i.e., without a red-lead coat under them. The ratings of these four paints at the end of one year and of 21 months, for both one-coat and two-coat samples, are given in Table I. These plates have now been exposed for about 24 months, having been placed in their present position in April, 1911.

RESULTS OF THE TESTS

The results so far are very instructive, and would be much more so if complete analyses of all the ready-mixed paints could be included in this report.

Table 2 gives the averages of the results obtained with the various kinds of paints. The first group includes the entire number of red-lead paints tested, namely 53, and includes both the ready-mixed samples and also those mixed in the laboratory; the ratings given are the averages of all the tests. The second group is composed of the 42 ready-mixed paints (all of which are included in the first group). In the third group are the 5 straight red-lead paints mixed from the dry pigments in the laboratory. The fourth group includes the 6 red-lead paints mixed in the laboratory, to which either china clay or asbestine had been added. The next group, the fifth, is

TABLE I. RATINGS OF SECOND-COAT PAINTS BY THEMSELVES (WITHOUT PRIMING COAT)

Kind of paint	Ratings			
	1 coat		2 coats	
	1 yr.	21 mo.	1 yr.	21 mo.
Tar product	70	65	80	65
Iron oxide	80	70	90	80
Graphite	0	0	75	70
Carbon	0	0	80	70

TABLE II. RESULTS OF EXPOSURE TESTS OF PRIMERS

Group No.	1st coat	2d coat	Ratings			
			1 year		21 mo.	
			1 coat	2 coats	1 coat	2 coats
1	53 RED LEAD Paints both ready-mixed and mixed from dry pigments.	Same as first	47.4	70.3	38.5	62
		Tar product	....	90.7	....	86.8
		Iron oxide	....	85.7	....	72.8
		Graphite	....	80.	....	69.8
		Carbon	....	83.1	....	74.2
2	42 RED LEAD ready-mixed paints.	Same as first	45	68.3	38.6	60
		Tar product	....	90	....	87
		Iron oxide	....	84	....	72.5
		Graphite	....	79.8	....	70.4
		Carbon	....	81.8	....	74
3	5 RED LEAD Paints mixed from dry pigments.	Same as first	51	74	21	68
		Tar product	....	94	....	83
		Iron oxide	....	89	....	76
		Graphite	....	78	....	65
		Carbon	....	85	....	72
4	6 RED LEAD Paints, mixed from dry pigments with ASBESTINE or CHINA CLAY suspenders.	Same as first	61	80	52.5	70
		Tar product	....	96	....	87.5
		Iron oxide	....	93.3	....	73.3
		Graphite	....	83.3	....	69
		Carbon	....	91.7	....	76
5	8 LITHARGE paints mixed from dry pigments, both straight litharge and combined with suspenders.	Same as first	64	82	60	73
		Tar product	....	95.6	....	86.9
		Iron oxide	....	90	....	69.4
		Graphite	....	86.9	....	72
		Carbon	....	84.4	....	69.4
6	2 straight LITHARGE paints mixed from dry pigments.	Same as first	67.5	85	62.5	77.5
		Tar product	....	92.5	....	77.5
		Iron oxide	....	92.5	....	65
		Graphite	....	85	....	72.5
		Carbon	....	85	....	70
7	6 LITHARGE paints mixed from dry pigments with ASBESTINE or CHINA CLAY suspenders.	Same as first	63.3	80.6	59.2	71.7
		Tar product	....	96.7	....	90
		Iron oxide	....	89.2	....	71
		Graphite	....	87.5	....	71.7
		Carbon	....	84	....	69.2

composed of 8 litharge paints, two of which are straight litharge, and the other 6 contain a suspender in the form of china clay or asbestine. The sixth group contains the two straight litharge paints. The seventh and last group is made up of the 6 litharge paints which had had a suspender added.

All the figures given are averages of all the paints in the group and represent the relative protection afforded by the paints on an arbitrary scale, 100 being perfect.

It may be interesting to note what these results mean.

First: Note the ratings of each of the first four groups, which are all red leads, after one year exposure with one coat only. The average of all tests was 47.4, the ready-mixed group averaged 45, the straight red leads (third group) averaged 51, and the group of pure red leads with suspenders added averaged 61, *or 10% better than the straight red leads without suspenders.*

paint as the first coat. It will be found that what has been pointed out above in connection with one-coat results applies also to the two-coat averages, namely, (a) the straight red leads (third group) are better than the average ready-mixed, (b) the fourth group or pure red leads with a suspender added are better than either, and (c) the litharge groups show higher averages than the red leads.

The general result of this series of tests indicates that the addition of sufficient filler or suspender to prevent the settlement and hardening of red lead in the package is not detrimental to red-lead paint as a protector of steel exposed to the weather.

Comparison of Second-Coat Paints

It is also interesting to compare the results obtained with the four kinds of second-coat paints over the various priming coats. The one thing that stands out most

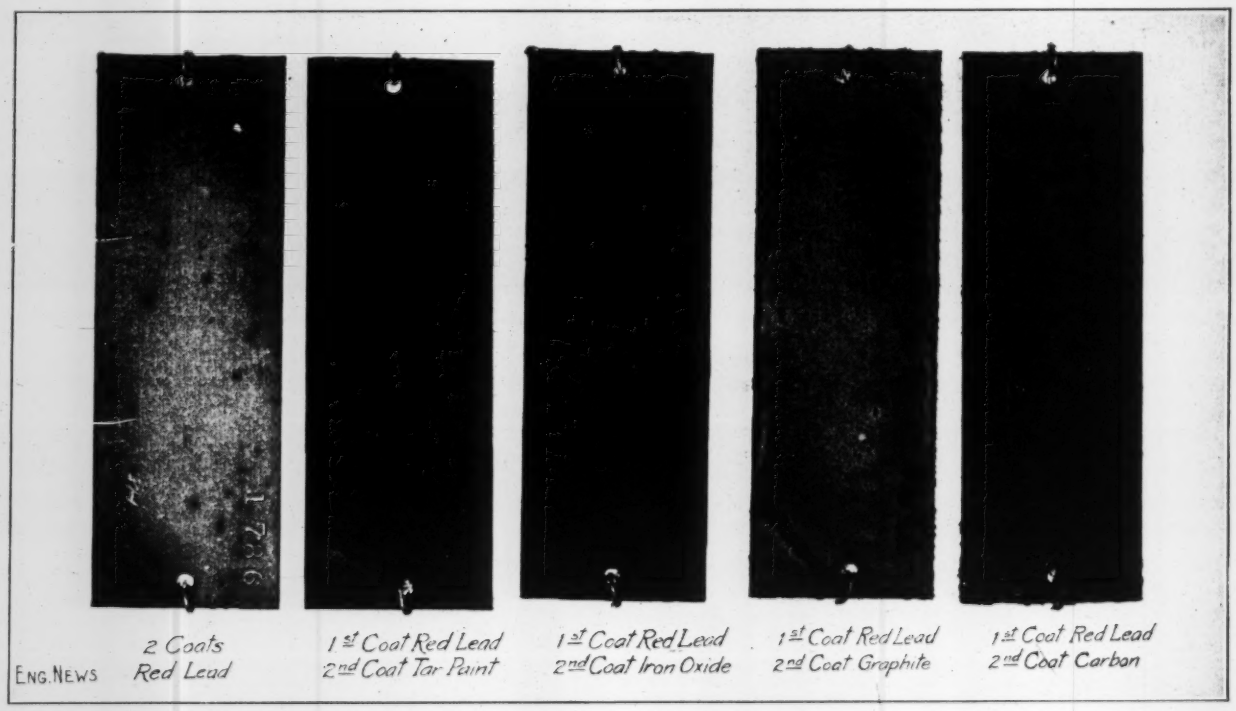

ENG. NEWS
2 Coats Red Lead
1st Coat Red Lead 2nd Coat Tar Paint
1st Coat Red Lead 2nd Coat Iron Oxide
1st Coat Red Lead 2nd Coat Graphite
1st Coat Red Lead 2nd Coat Carbon

Fig. 3. Typical Specimens (Not from Same Set), Showing Manner of Failure of the Paints Tested

Second: Note that for one-coat specimens exposed 21 months the straight red leads of the third group have fallen off much more rapidly than the ready-mixed paints of the second group, having dropped from 51 to 21 while the ready-mixed fell from 45 to 38.6.

Third: The pure red leads with a suspender added (fourth group) are showing up to much better advantage after 21 months than they did at the end of the year, being 14% above the average of all tests (group one) and 31.5% ahead of the straight red leads of the third group.

Fourth: Pass now to the last three groups, which are litharge, and compare the one-coat averages for 1 year and 21 mos., with those of the red leads in the first four groups. In all cases the advantage seems to be on the side of litharge. The addition of the suspenders does not seem to increase the durability of the paints as in the case of red lead.

Fifth: Examine the two-coat averages at 1 year for those specimens which have a second coat of the same

prominently and consistently is the superiority of the tar paint over the other three. In every case the tar paint showed up superior to the iron oxide, graphite or carbon groups.

This result should not be interpreted to mean that *any* tar paint is better than an iron-oxide paint or a graphite or carbon paint. As a matter of fact the general run of hydrocarbon paints offer poor protection to steel exposed to the weather. Of the many hundreds of samples of paints tested by Westinghouse, Church, Kerr & Co., no class shows much poorer results than the hydrocarbons (tar and asphalt), but there are a few paints in this class which stand up very well indeed, thus demonstrating the possibility of making a good paint from these materials even though the very great majority of those on the market are very poor.

In Fig. 3 are shown five plates selected from the entire series with a view to showing the typical appearance of the failure of the different paints. In this connection attention may be called to the tendency of graphite

TRAIN-MINUTE DETENTIONS ETC., OF THE NEW YORKCENTRAL & HUDSON RIVER R.R., NEW YORK TERMINAL ZONE UNDER ELECTRIC TRACTION; FOR YEAR 1912

	Train-minute detention																				Mileage			Average miles per minute detention		
	Electric power troubles							Electric locomotives										Multiple-unit cars								
	Power stations	Substations	10,000-volt trans. line	6,000-volt trans. line	Third-rail	2,200-volt signal line	Total	Fuses	Contactors	Reversers	Misc. Elec.	Brakes	Misc. mech.	Total	Relays	Control jumpers	Misc. elec.	Brakes	Hot boxes	Misc. mech.	Total	Total for all causes[1]	Electric locos.	Total	Electric zone	Total	Elec. delays	Mech. delays
January	..	4	..	..	..	63	67	1	31	14	..	4	12	62	13	..	39	18	9	..	86	215	113,972	422,347	366,652	422,347	1,838	6,214	15,642	2,494
February	..	..	..	..	..	..	9	..	11	..	11	8	..	30	6	3	..	8	..	22	43	82	103,171	390,375	328,787	390,375	3,439	26,060	13,012	6,019
March	..	..	..	..	7	..	9	3	2	..	..	14.5	..	19.5	2	4	15	13	..	7	77	105.5	108,952	363,883	419,413	419,413	5,587	12,996	8,559	5,008
April	..	..	..	..	18	25.5	25.5	..	..	..	17	..	61	61	3.5	7	19	8	3	5	50.5	137	115,177	356,758	409,472	409,472	1,888	10,341	25,592	3,829
May	..	..	..	..	..	3	29	6	..	9	6	9	5	31	..	13	..	6	..	..	6	58	114,203	376,134	432,102	432,102	4,965	..	72,017	9,419
June	..	..	..	..	..	3	3	2	..	2.5	3	4	..	20.5	..	..	..	..	4	..	74	108	112,167	359,737	417,458	417,458	3,618	9,224	11,927	4,904
July	..	..	..	..	..	7	7	..	11	..	..	..	..	7.5	..	..	9	20	19	57	144.5	172	113,149	359,351	421,166	421,166	5,519	6,250	4,841	3,106
August	..	..	..	..	17	6	23	2.5	..	..	..	..	..	2.5	3	..	14	15	..	9	44	69.5	115,548	341,124	400,127	400,127	46,219	17,056	16,672	7,420
September	..	..	..	..	..	..	..	13	..	..	3.5	..	..	16.5	3	..	8	..	15	..	23	39.5	115,157	338,900	397,520	397,520	6,379	42,362	26,501	12,979
October	..	..	..	..	..	5	5	5	..	2	..	3	..	10	3	..	37	..	15	..	55	70	116,575	369,877	426,600	426,600	11,657	9,247	28,440	7,759
November	..	..	..	..	..	4	4	..	..	..	..	..	..	..	..	..	6	5	14	..	35	39	110,790	355,394	409,795	428,112	10,247	22,212	21,568	13,348
December	..	..	5	..	..	28	33	..	..	..	..	6	5	11	11	..	11	11	..	..	102	206	112,716	371,036	428,112			4,470	5,419	2,625
Total	..	4	25	..	42	143.5	214.5	30	57.5	27.5	40.5	48.5	83	287	35.5	23	186	194	108	100	800	1301.5	1,351,577	4,279,633	4,974,487	4,709	10,798	12,374	4,861

[1] Does not include delays to New Haven trains. [2] Based on total mileage of locomotive and multiple-unit cars. ("Multiple-unit cars" signifies trailer and motor cars.)

and carbon to start rusting at the edges of the plates and over the stamped numbers, while red lead tends to start on the body of the plate while the numbers and edges are quite free from rust spots.

⁂

Results of Electric Traction on the New York Central Railroad at New York City

Reliability of electric traction at Grand Central Terminal was discussed by E. B. Katte before the New York Railway Club, on Mar. 20. He reported that the Hudson division of the New York Central was now operating 56 electric trains a day equivalent to 7000 multiple-unit-car miles, and that the Harlem division was running 72 trains a day equivalent to 7800 car miles. The average number of trains operated in and out of Grand Central Terminal was 525 a day and a new record of reliability had been made, compared with previous years. The electric locomotives had operated 8691 miles and the multiple-unit cars, 10,798 miles for each minute of detention due to electrical causes. The locomotives had run 10,277 miles and the multiple-unit cars 12,374 miles per minute of detention due to mechanical causes. Details of these data are given in the table reprinted herewith.

The equipment has now been in operation for more than six years. During 1912 the cost for maintenance of locomotives, including shop expenses, painting, etc., was 3.34c. per mile, compared with 3.2c. in 1910 and 3.08c. in 1911. Similar maintenance expenses in the multiple-unit cars were 1.08c. per car mile in 1912, 2.1c. in 1911, and 1.9c. in 1910.

⁂

Hypochlorite Water Disinfection in Flooded Districts is being recommended by officers of the U. S. Public Health Service on duty at Evansville, Ind., Cairo, Ill., Louisville, Ky., and Memphis, Tenn., under directions from the Service. Where no public water-supplies are available, it is to be recommended that a hypochlorite solution be distributed free to homes for use in water treatment. "Public Health Reports" for Apr. 18, 1913, stated that "a satisfactory solution may be made by adding 1 teaspoonful of chlorinated lime to 1 pint of water. Of this solution 1 teaspoonful may be added to 2 gal. of drinking water, which should then be allowed to stand for at least one-half hour before being used." The officers named have also been instructed to recommend disinfection of cesspools and privies with quicklime or chlorinated lime, and also to give instructions designed to check outbreaks of various communicable diseases.

The Abatement of Smoke in Cincinnati, Ohio, is being studied by a commission of citizens known as the United Smoke Committee. A recent conference was held by a subcommittee on smoke from locomotives and engine houses, with representatives of the railroads entering the city. From the discussions it became evident that the kind of fuel which must necessarily be used by any road was that which could be most cheaply and conveniently obtained in the territory covered by that line. Oil fuel was not easily obtained and there was no surety of continuance of supply. Coke had been tried, but proved too bulky. The use of steam jets in the firebox over the fuel bed produced marked improvement in the emission of smoke, and nearly all the roads were reported as having equipped or equipping a considerable number of their engines with this device. Careful operation was necessary, however, and constant inspection. Mechanical stokers were discussed, but were not conceded to be applicable for yard service, on account of the cost of installation and the irregularity of operation. The responsibility of firemen and engineers in reducing smoke was brought up. Much depended on the way the engineer handled his engine and on the laziness of some firemen in firing large amounts at one time instead of distributing smaller amounts over a longer period.

Track Elevation at Joliet, Ill.

SYNOPSIS—Track elevation for the elimination of street crossings at grade has been recently carried out at Joliet, Ill., at a cost of about $2,000,000. Four railway companies were involved, their lines intersecting the city in both directions, and intersecting each other (with a railway crossing at grade) in the heart of the city, so that the work and its execution had to be planned as a whole. The general plan of the work and the detailed design of the bridges and subways at street crossings are of interest to engineers engaged on similar work.

The railway track elevation at Joliet, Ill., which has been completed recently, presented somewhat exceptional problems, owing to the fact that two groups of railways crossed the city in opposite directions and that passenger stations, freight yards and industrial facilities were involved. All the tracks were at the street level and there was a grade crossing of the two groups of lines. The tracks and facilities were close to the business district of the city, so that the trains and the switching service caused considerable interference with street traffic. The removal of the tracks from the street surface, and the rearrangement of the track layout in the city, involved difficult and interesting work, some features of which are described below. The information is taken largely from a paper on "The Track Elevation of the Chicago & Alton R.R. at Joliet, Ill.," read before the Illinois Society of Engineers and Surveyors by R. A. Cook, Assistant Engineer of the Chicago & Alton R.R., who was in charge of the work for that railway, and to whom we are indebted for drawings of the structures.

The entire cost of the work has been borne by the railways, with the exception of property damages, which were borne by the city. The total cost to the railways has been about $2,000,000. The railway traffic at Joliet is very heavy for a city of its size. This is owing to its being largely a manufacturing and industrial center and only 38 miles from Chicago, to which it is connected by three railways. The population of Joliet is given as nearly 35,000 by the census of 1910, but the residents usually give a higher figure owing to the fact that there is a considerable population just outside the city limits.

The work of elevating the tracks was begun in 1908 as a result of an ordinance which was passed by the City Council on Jan. 22, 1906, and was accepted by the railways. The railways affected were the Chicago & Alton, the Atchison, Topeka & Santa Fé, the Chicago, Rock Island & Pacific, the Michigan Central, and the Elgin, Joliet & Eastern. This last named road has nearly all of its tracks outside of the track elevation territory, and therefore it decided to abandon those within the territory rather than to elevate them.

The other lines may be divided into two groups. The first comprises the Chicago & Alton R.R. and the Atchison, Topeka & Santa Fé R.R., whose tracks and right-of-way extend through the city in a north and south direction and adjacent to each other, being located two blocks east of the business district. The second group comprises the Chicago, Rock Island & Pacific R.R. and the Michigan Central R.R., whose tracks and right-of-way extend through the city in an east and west direction, being located about two blocks south of the center of the business district. Prior to the track-elevation period, the tracks of the Michigan Central R.R. did not extend west of the Chicago & Alton R.R., but the company has now extended its line west to the city limits and beyond. For this it used the same roadbed with the Rock Island tracks, which have been located on a new right-of-way two blocks south of the old location.

The work of the Atchison, Topeka & Santa Fé R.R. was under the direction of C. A. Morse (then Chief Engineer), with G. W. Vaughn in charge as Engineer of Track Elevation. The work of the Chicago, Rock Island & Pacific R.R. was under J. B. Berry, Chief Engineer, and that of the Michigan Central R.R. under G. H. Webb, Chief Engineer; the work of these two roads was done jointly and was in charge of G. H. Harris and A. T. Hopkins (at different times), Assistant Engineers

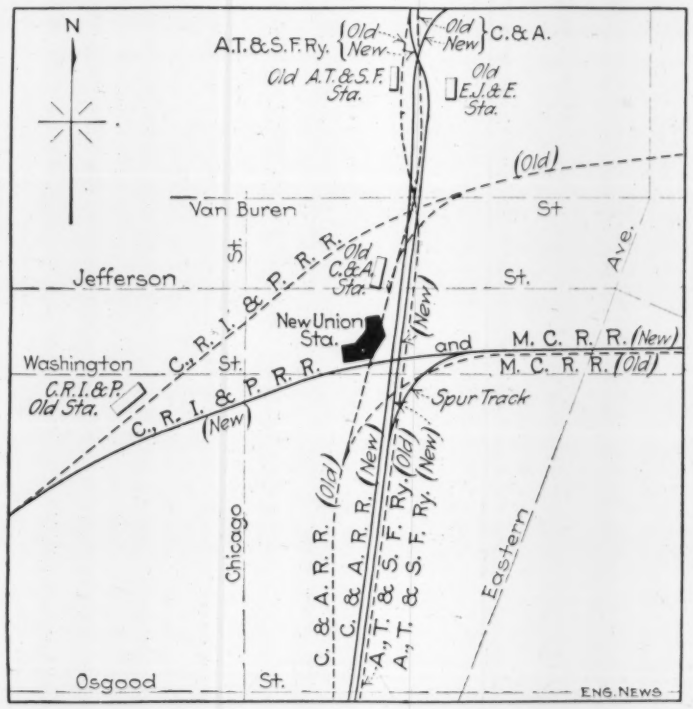


FIG. 1. TRACK PLAN OF THE OLD SURFACE LINES AND THE NEW ELEVATED LINES OF THE RAILWAYS TRAVERSING JOLIET, ILL.

of the Michigan Central R.R. and representing both roads. The work of the Chicago & Alton R.R. has been successfully under the jurisdiction of the former Chief Engineer, the late W. D. Taylor; the Assistant Chief Engineer, E. L. Crugar, and the present Chief Engineer, H. T. Douglas, Jr. R. A. Cook, Assistant Engineer, was in charge of the work.

THE OLD AND NEW TRACK PLANS

The general situation of the old and new lines is shown in Fig. 1. From the dotted lines representing the old arrangement it will be seen that originally there were two adjacent lines running north and south, but having a "scissors" crossing, the lines being parallel (but in reversed position) on either side of this crossing. A third line crossed the other two at grade and ran southwest across the city, while a fourth coming in from the east extended only as far as the north and south lines. The passenger stations were widely separated, and the entire arrangement was unsystematic and inconvenient.

The complicated grade crossing required all trains on the three roads to come to a full stop when in the busiest portion of the city, and frequently a train on one road would delay trains on the other roads until it had cleared the crossing. Probably the busiest street involved is Jefferson St., and this was crossed by all three roads, so that the chances of obstructing it were threefold.

The tracks of the Alton and Santa Fé railways crossed 14 streets at grade, the distance between the two outside streets being 1½ miles. The track-elevation ordinance, however, provided only for the elimination of the 11 south crossings (seven streets to be provided with subways and four to be closed), and it did not provide for the elimination of the three north crossings. The distance between the first and seventh streets to be provided with subways is ⅞ mile. The length of the Chicago & Alton R.R. which has been elevated, including approaches, is 1½ miles.

Under the old arrangement of tracks at grade, the Alton and Santa Fé railways each had independent tracks, those of the Santa Fé being west of the Alton tracks, north of the Rock Island crossing, and on the east side south of the crossing. The two companies now have a joint four-track line from Cass to Osgood Sts., a distance of 3200 ft., but each has its own double-track line north and south of these streets. The position of these separate double-track lines has not been changed essentially from the old alignments, but their crossing (north of the Rock Island grade crossing) has been improved. The joint tracks, however, do not coincide with either of the old alignments, being situated for the most part between them. The length of the Alton main tracks which have been elevated, including those on approaches, is 1.84 miles, and of the Alton and Santa Fé joint tracks 2.12 miles.

The profile of the elevated tracks between the outside subways is very nearly level, and the amount which the tracks have been raised within the same limits varies between 9 ft. and 16½ ft. At the north end of the work there is an ascending grade southward of 0.78% to the level of the new elevated line. At the south end, however, the old grade is ascending southward, so that the new elevated line runs into it on an ascending grade of 0.13%.

Subways

In addition to raising the tracks, the streets were also depressed, the amount of depression varying from nothing at Osgood St. to 6.6 ft. at Fifth Ave. (at the south end of the work). The most important streets (Cass St. and Jefferson St.) were depressed 3.4 and 2.8 ft. respectively. The rate of grade of the street approaches is in all cases 3.5%. The width of roadway in the subways is 36, 42 or 50 ft. All the streets are 66 ft. wide, and no contraction in width has been made except at Washington St., where a small subway 21 ft. in width was provided. The overhead clearance in all subways is 12 ft., except at Cass St., Jefferson St. and Fifth Ave., where it is 13.5 ft. on account of the electric street-car lines. The drainage of all subways is taken care of by sewers previously constructed, except that a new sewer had to be built for the Cass St. and Clinton St. subways. In all the subways the roadways are paved with brick on a concrete base, and the sidewalks are of concrete. The pavements, sidewalks, catchbasins, etc., are constructed according to the city's specifications, the work being under the direction of H. A. Stevens, then City Engineer.

Bridges

On the Chicago & Alton R.R., the bridges over the streets are of three types: reinforced-concrete deck bridges, steel deck bridges, and steel through bridges. Deck bridges were provided wherever possible in order to eliminate girders between the tracks. The bridge at Washington St. is of reinforced-concrete, with a clear span slightly under 25 ft. The depth of the slab is 37 in. The concrete is a 1:2:4 mixture, reinforced with 1-in. corrugated bars.

Deck steel bridges were provided at four of the subways. In three of these, rows of columns were permitted along the curb lines and along the center line of the street. These columns support cross-girders, which in turn support 16-in. I-beams placed longitudinally with the tracks. The length of the roadway span of these bridges is either 21 or 25 ft. One subway bridge (Fig. 2) is similar to the above except that there are no columns on the center line of the street, and consequently 30-in. plate girders were used instead of I-beams for the roadway span of 36 ft. The two remaining bridges are

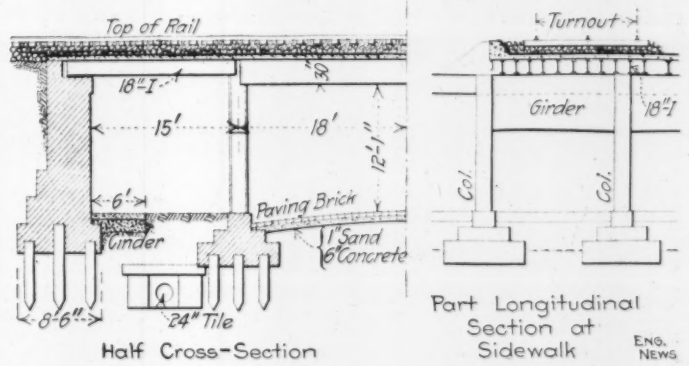


Fig. 2. Deck Bridge over the Osgood St. Subway at Joliet, Ill.; Chicago & Alton R.R.

of through-girder type, with transverse 12-in. I-beams (Fig. 4). The roadway span of one is 36 ft. and of the other 42 ft. All the steel bridges have a 4-in. reinforced-concrete floor, over which a 1½-in. layer of waterproofing is placed. This waterproofing consists of a coat of asphalt paint, three layers of burlap, and one layer of saturated felt, each layer being thoroughly mopped with hot asphalt before the next one above was applied. These are covered with an asphalt mastic for purposes of protection. The track is laid over this floor, with 6 to 9 in. of stone ballast under the ties.

Limestone bedrock is found at depths below the ground surface varying from 4 ft. at the north end of the work to about 11 ft. at Osgood St. and 22 or 23 ft. at the south end. All foundations north of Osgood St. were carried to bedrock, the material above the rock being gravel, clay and filling. South of Osgood St. the masonry was built upon coarse gravel and boulders which overlie the rock. All abutments and retaining walls are of 1:3:6 concrete. Either crushed limestone or crushed and washed gravel was used in the concrete, the latter being preferred. The aggregate length of retaining walls is 2200 ft., and the heights vary from about 6 to 22 ft. All are built upon bedrock. Both retaining walls and abutments are of gravity section.

As to the use of gravel for concrete on this work, although Joliet is the center of the limestone industry, it

appears that the former cost 33% less than the latter, while it was easier to handle and therefore preferred by the foremen. The gravel also was harder than limestone. In cinder pits, it was found that the heat-affected limestone concrete, but had no visible effect on gravel concrete.

Fig. 2 shows the deck bridge at Osgood St., and Fig. 3 shows its floor construction. This bridge crosses the street at an angle of 83°. It carries six tracks, with switches and crossovers, and therefore an unobstructed deck was necessary. There are two rows of columns, forming a 36-ft. roadway span and two 15-ft. sidewalk spans. The columns are spaced 14 ft. 4½ in. longitudinally, there being six in each row and the width of the bridge being about 75 ft. Between the columns are framed two lines of 5-ft. girders, the tops of which carry the 30-in. longitudinal girders of the roadway span and the 18-in. longitudinal I-beams of the sidewalk spans.

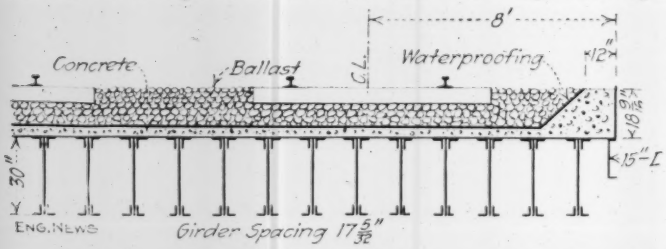


FIG. 3. FLOOR CONSTRUCTION OF DECK BRIDGE

The girders and beams are spaced uniformly 17 5/32 in. under the tracks and 34¼ in. between two groups of tracks.

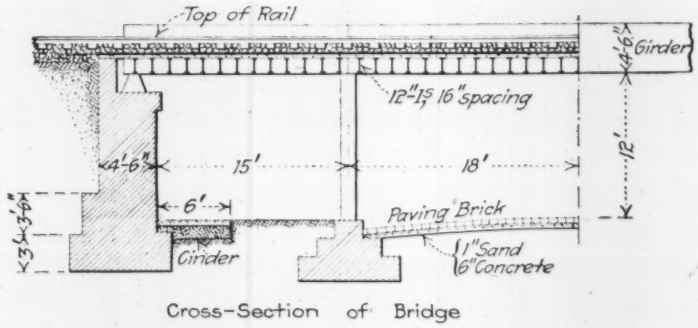
A concrete-slab floor is laid upon the beams and girders, and has a curb wall at each side to retain the ballast, there being a 15-in. channel as a facia girder under the curb wall. Upon the concrete is the waterproofing course, and the ballast over this bridge is 6½ to 7½ in. deep under the ties.

The through plate-girder bridge at 4th Ave., shown in Fig. 4 carries only the double-track line of the Chicago & Alton R.R. It has but three columns in each row, and these are directly under the girders, spaced 13 ft. apart. The floor system consists of 12-in. I-beams 16 in. apart, resting on the bottom chords of the girders. Upon these is a concrete slab reinforced with two layers of ½-in. longitudinal bars 6 in. apart. The concrete is carried up against the girders to form a trough for each track, and is covered with a waterproofing course. Upon this is the ballast, which has a depth of 9 in. under the ties at one end of the bridge and 5 in. at the other end.

On the work of the A., T. & S. F. R.R., the bridges are of steel, with ballasted floors. The deck bridges have transverse plate-girders placed on the tops of steel columns at the curbs and centers of streets, and the girders carry 15-in. longitudinal I-beams about 18 in. apart. Upon these is the floor slab of reinforced-concrete. The through bridges have plate-girders with transverse 15-in. I-beams carrying a concrete floor slab.

On the new east and west elevated line (the relocated line of the Rock Island and Michigan Central Rys.), most of the subways have longitudinal girders with transverse I-beams carried either by the bottom flanges of the girders or framed against the girder webs with vertical angle-bracket connections. In the former case, a steel plate deck 10 ft. wide is riveted to the top of the I-beams, and a reinforced-concrete curb or guard is built at each side of the deck, having its top sloped up to the flange angles of the girders and covered with a waterproofing course. The concrete is anchored to the girders by bolts through the webs of the outside girders and by short rods through those of the intermediate girders (between the tracks). On this steel deck is laid about 6 in. of stone ballast under the ties. In the latter case (with the half-through spans) the I-beams carry a reinforced-concrete floor slab covered with waterproofing, the concrete being carried up over the tops of the girders. Stone ballast is laid in the trough thus formed.

A connecting track on a 15° curve, opposite the new union station, provides an interchange connection between the two sets of elevated tracks. This is carried across the intersection of Washington and York Sts. by a viaduct having eight spans of reinforced-concrete slabs, and three plate-girder spans at the north end where the angle of skew was too great to permit the use of concrete. The concrete slabs are about 24½ ft. long, 13½ ft. wide and 4 in. thick, the thickness being increased to 61 in. at the sides so as to form curb walls to retain the ballast. On one side, the top of the curb wall is extended to form a 4½-ft. cantilever sidewalk (5 in. thick), with brackets from the side of the slab. The slabs (which were cast



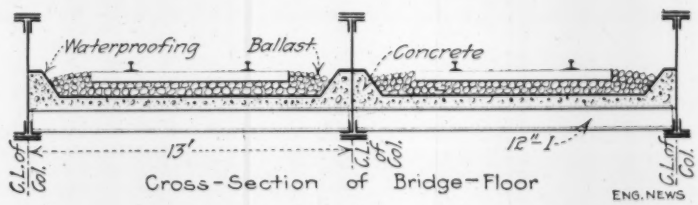


FIG. 4. THROUGH-GIRDER BRIDGE OVER SUBWAY AT FOURTH AVE., JOLIET, ILL.; CHICAGO & ALTON R.R.

in place) rest on reinforced-concrete bents composed of four columns and a cross girder, the columns resting on a continuous footing wall.

METHOD OF ELEVATING THE TRACKS

In carrying on the work of the two parallel and adjacent lines of the C. & A. R.R. and the A., T. & S. F. R.R., each road had its own independent forces, the former road undertaking the south half of the work and the latter taking the north half. Owing to there having been two sets of tracks, it was possible to do nearly all the work without having to run trains over it at the same time. This was a great advantage both from the operating and the construction standpoint. All trains were first operated on the east tracks (comprising the Chicago & Alton tracks north of and the Santa Fè tracks south of the Rock Island crossing) while the west elevated tracks were being constructed. Traffic was then

changed to these latter tracks, after which the east surface tracks were taken up and the east elevated tracks constructed.

Traffic was first run over the Alton and Santa Fè elevated tracks in July, 1910, while the Rock Island railway continued to operate its surface tracks until November, 1912. This condition made it necessary for the Alton and Santa Fè companies to construct a temporary hump in the elevated tracks at the Rock Island crossing, of sufficient height to carry their trains over those of the Rock Island. This was due to the greater clearance height required in crossing a railway, and the hump was about 8 ft. above the permanent elevation of the elevated tracks. This portion of the work was built on trestle.

The filling material used by the Chicago & Alton R.R. was mainly fine sand which was obtained from a deposit on the line of the road about 20 miles south of Joliet, at Braidwood. The sand was loaded with a steam shovel and unloaded mainly with power-operated unloader plows. Very nearly all the filling was put in without the use of trestles, except across the streets. The sand was covered with a layer of dirt or cinders to prevent the wind from blowing it onto adjacent property. Concrete was made in a 1½-yd. mixer. To supply the mixer and deposit the concrete, small steel dump cars on narrow-gage industrial tracks were used wherever practicable and with satisfactory results. The materials were handled directly from cars into the mixer. All work of every description carried on by the Chicago & Alton R.R. (except the moving of large buildings) was done by the company's forces.

Auxiliary Works

In addition to the track-elevation work proper, there has been a very considerable amount of other work occasioned by it. The Chicago & Alton R.R. owns a large piece of land between the old Rock Island tracks and Osgood St. On this were situated the main tracks, the passenger station, freight station and other buildings; the main freight yard, team tracks, a seven-stall brick roundhouse with turntable, cinder pits, etc. There also were stock pens and various industries.

The transformation of this piece of property has been most complete. The industries have been moved to new locations by the Rock Island R.R., in connection with obtaining the right-of-way for its new line. The passenger station was torn down and the freight station moved to a new location. The roundhouse, turntable, cinder pits and the main yard were torn down or taken up, and were rebuilt at South Joliet, two miles south of the city. New industries were brought in and an entirely different arrangement of tracks has been made, including ample provision for team tracks and driveways. In fact, with the exception of two or three tracks, every structure on the Alton company's right-of-way within the city limits of Joliet has been taken up and rebuilt or has been moved.

One feature of the work which has not yet been completed is an interlocking plant which will govern all train movements at and near the crossing of the north and south with the east and west lines. There will be four main tracks for the Alton and Santa Fè railways, and four for the Rock Island and Michigan Central railways; also numerous switches and crossovers, and a transfer connection between the two lines. The total train movements will be about 200 per day.

Union Station

A noteworthy feature of this improvement is the union passenger station which has been constructed by the Alton, Santa Fè and Rock Island railways at the intersection of the north and south with the east and west lines, and fronting on Jefferson and Scott Sts. This was opened on Nov. 1, 1912, and represents an expenditure (including foundations) of about $300,000. It is a two-story building. The ticket office, ticket lobby, and baggage and express rooms are on the ground floor. The main waiting room, women's room, and toilet rooms are on the second floor, which is at the track level. The platforms are of concrete and brick, with canopy shelters, and are of sufficient length to accommodate ten-car trains. The track spacing at the platforms is 28 ft. for the north and south lines, and 26 ft. for the east and west lines. There is a subway giving an entrance under the tracks from Michigan St. on the east side, and providing a means of access (without crossing tracks) to the island platforms.

The building is faced with Bedford stone laid in ashlar masonry and backed with brick. The foundations are of concrete and some of the columns and the roof trusses are of steel. The roof is a concrete slab covered with slate. Reinforced concrete has been used very largely throughout the building. In the design, the architectural features were given more attention than has been customary for railway stations in cities of the size of Joliet. The architect was Jarvis Hunt.

❖

The City Manager Plan has been adopted by Hickory, N. C., as a part of a new charter. It seems likely that an engineer will be selected and it is possible that applicants for the position will be invited by advertisement, but neither of these points will be determined until after the election of the new city council, on Apr. 28. The population of Hickory was 3716 in 1910. We are indebted to H. S. Gilbertson, assistant secretary of the National Short Ballot Organization, 383 Fourth Ave., New York City, for the foregoing information and also for the following extracts from the new charter for Hickory:

Sec. 9. He [the city manager] shall have power to revoke licenses pending the action of the City Council.

Sec. 10. He shall have authority and charge over all public works, the erection of buildings for the city, the making and construction of all improvements, paving, curbing, sidewalks, streets, bridges, viaducts, and the repair thereof; he shall approve all estimates of the cost of public works, and recommend to the City Council the acceptance and rejection of the work done or improvements made; he shall have control, management and direction of all public grounds, bridges, viaducts and public buildings; he shall have control of the location of street-car tracks, telephone and telegraph poles and wires; he shall have charge of the watersheds from which the city takes its supply of water, pumping stations, pipe lines, filtering apparatus, and all other things connected with or incident to the proper supply of water for the city; and shall secure all rights of way and easements connected with the water-works or sewerage systems or the extension of the streets, etc.

All the powers enumerated, however, shall be exercised subject to the supervision and control of the City Council.

Other cities which have already engaged city managers are Staunton, Va. ("Eng. News," July 8, 1909, pp. 32 and 42), and Sumter, S. C. ("Eng. News," Oct. 24, 1912). Proposals for its adoption elsewhere, with editorial comments on "The City Manager Plan" were noted in our issue of Mar. 13, 1913. Mr. Gilbertson informs us that the plan is now being advocated for Wisconsin cities of the second to fourth classes and that a bill to that end has been introduced in the Wisconsin legislature.

We are also informed by Mr. Gilbertson that there were some 150 applications for the city managership of Sumter, S. C. (unlike Hickory, N. C., a commission plan city), largely from engineers. The first city manager selected by Sumter, we understand, accepted a better position elsewhere, before assuming office. In January, 1913, M. M. Worthington, a civil engineer, was chosen city manager of Sumter, at $2400 a year.

A Method of Proportioning Concrete

By William B. Hunter*

The writer submits herewith the results of studies as to a simple method of proportioning the ingredients of concrete so as to insure a satisfactory quality of concrete and at the same time to avoid the use of an excessive amount of cement.

Several methods for proportioning concrete have been proposed and are in use. These may be outlined as follows:

(1) A careful mechanical analysis of the aggregates and the grading of the same so as to get small percentages of voids, thereby reducing the amount of cement required to a minimum. This may be called the ultra-scientific method.

(2) Arbitrarily fixing the proportions of cement to the aggregates; as one part cement, two parts fine aggregate and four parts coarse aggregate, commonly spoken of as 1 : 2 : 4 concrete.

(3) Adopting a given cement factor; i.e., the number of barrels of cement to be used per cu.yd. of concrete; as a cement factor of 1.80 or 2.10, etc., and adjusting the proportions of the aggregates from time to time to fulfill these conditions.

(4) Determining the amount of cement in excess of the voids in the fine aggregate required to make an acceptable mortar and the amount of mortar in excess of the voids in the coarse aggregate required to make an acceptable concrete, and then after determining the per cent. of voids in the aggregates, proportioning the ingredients so as to fulfill these requirements.

Method 1 may be dismissed without further consideration on the ground of its impracticability.

Methods 2 and 3 are usually satisfactory and, where the character of the aggragates remains constant, obtain practically the same results as the fourth method. With very little experimenting and the exercise of good judgment, satisfactory results can be obtained. There are, however, objections to these methods, where the aggregates are variable, especially in the percentages of voids contained. For example, assume a 1 : 2 : 4 mixture, which is usually expected to give a rich mixture with a considerable excess of cement and mortar over the voids in the fine and coarse aggregates respectively.

With 40% voids in both fine and coarse aggregate, which may be considered as a fair average, with 1 part cement, 2 parts fine aggregate and 4 parts coarse aggregate there is an excess of 0.2 parts cement over the voids in the fine aggregate and an excess of 0.6 parts mortar over the voids in the coarse aggregate, which gives 4.6 parts concrete.

On a basis of 3.62 cu.ft. of cement per bbl., this gives a cement factor of 1.62. This mixture would give good results, and the cement factor is about what is ordinarily expected.

But, with 50% voids in fine and coarse aggregate, again with 1 part cement, 2 parts fine aggregate and 4 parts coarse aggregate, there is no excess of cement or of mortar and there results four parts concrete.

It is evident that it would be very difficult to get satisfactory results with this mixture in many structures, such as conduits, thin walls, etc., where the ratio of the superficial area to the volume of concrete is large and smooth surfaces are required, and yet the cement factor would be 1.86, which would ordinarily be expected to give excellent results.

Again, with 30% voids in aggregates and 1 part cement, 2 parts fine aggregate and 4 parts coarse aggregate there is an excess of 0.4 parts cement over the voids in the fine aggregate and an excess of 1.2 parts mortar over the voids in the coarse aggregate, which gives 5.2 parts concrete.

It is easily seen that with these last conditions, satisfactory results would be obtained, but the cement factor in this case is only 1.43.

From the above it is apparent that a high cement factor does not necessarily insure a good concrete, nor does a low cement factor necessarily result in an inferior quality of concrete.

The fourth method is the result of the writer's endeavor to formulate a method which will meet the objections to the second and third, and could be used in conjunction with the first, if it were practicable to impose the conditions of that method. For the purpose of illustrating the use of this method three diagrams are herewith presented.

Diagram 1 is based on the assumption that it is desired to obtain a concrete in which the quantity of cement remaining after filling the voids in the fine aggate will be 20% of the gross volume of the fine aggregate and the quantity of mortar remaining after filling the voids in the coarse aggregate will be 20% of the gross volume of the coarse aggregate.

Diagram 2 is prepared on the assumption that it is required to have 30% excess of cement, as previously described, after the voids in the fine aggregate are filled, and 20% excess mortar after the voids in the coarse aggregate are filled.

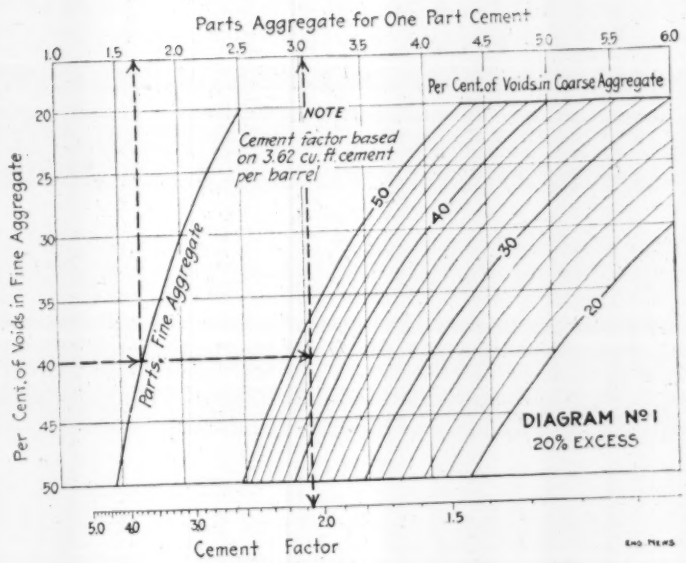
Diagram 3 is submitted to indicate the application of this principle where the voids in the fine aggregate can be considered as constant, as is often the case, and the voids in the coarse aggregate are variable. In this case one diagram can be made to cover all percentages of excess mortar over the voids in the coarse aggregate for a given percentage of excess cement over the voids in the fine aggregate. The diagram is based on the assumption that the voids in the fine aggregate are 40%, and is computed to give an excess of cement after filling the voids in the fine aggregate of 30% of the gross volume of the fine aggregate and 0 to 30% excess mortar after filling the voids in the coarse aggregate, the voids in the coarse aggregate varying from 20% to 50%.

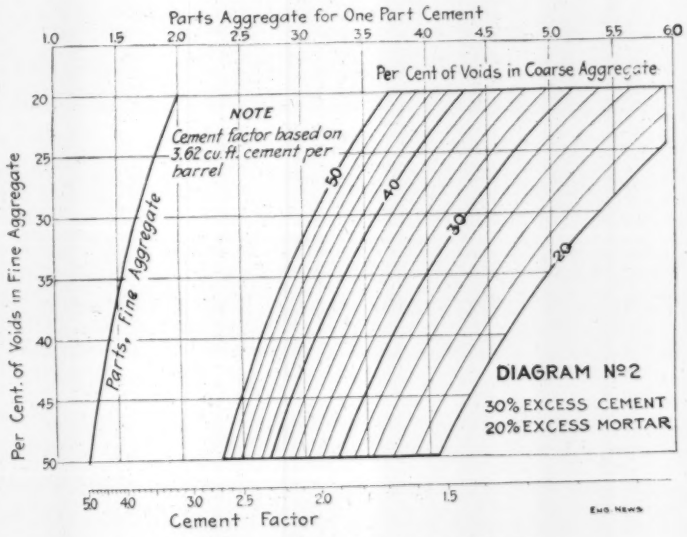
In Diagrams 1 and 2 the curve "parts of fine aggregate" can be used alone where a single aggregate is used.

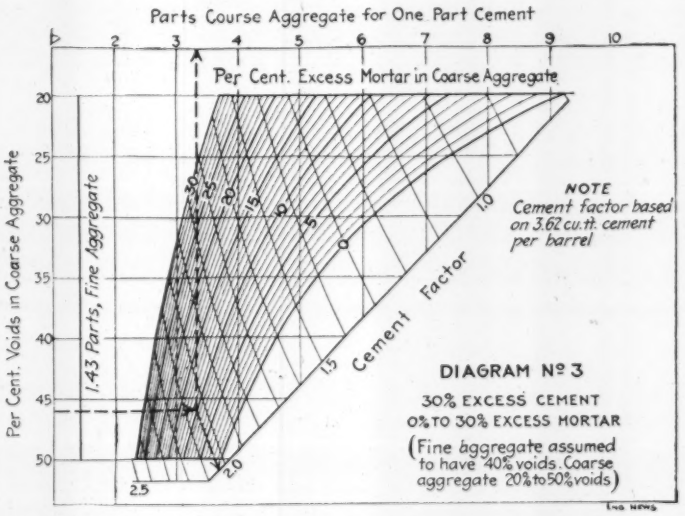
The accompanying tabulation shows the comparison of results by this method, using Diagram 1, with the standard proportions 1 : 2 : 4, frequently used where a rich concrete is required.

	Proportion	Percent. voids F. agg.	Percent. voids C. agg.	Percent. excess Cement	Percent. excess Mortar	Cement Factor
Fixed proportions.	1:2:4	50	50	0	0	1.86
20% excess.....	1:1.43:2.45	50	50	20	20	2.53
Fixed proportions	1:2:4	40	40	10	15	1.62
20% excess.....	1:1.67:3.33	40	40	20	20	1.86
Fixed proportions.	1:2:4	40	30	20	30	1.43
20% excess.....	1:2:4.8	30	30	20	20	1.30
Fixed proportions.	1:2:4	40	30	10	25	1.49
20% excess.....	1:1.67:4	40	30	20	20	1.55

*Assistant Engineer, Board of Water Supply, City of New York; 700 W. 181st St., New York City.


Parts Aggregate for One Part Cement
Per Cent. of Voids in Fine Aggregate
Per Cent. of Voids in Coarse Aggregate
NOTE
Cement factor based on 3.62 cu. ft. cement per barrel
Parts, Fine Aggregate
DIAGRAM Nº 1
20% EXCESS
Cement Factor


Parts Aggregate for One Part Cement
Per Cent. of Voids in Fine Aggregate
Per Cent of Voids in Coarse Aggregate
NOTE
Cement factor based on 3.62 cu. ft. cement per barrel
Parts, Fine Aggregate
DIAGRAM Nº 2
30% EXCESS CEMENT
20% EXCESS MORTAR
Cement Factor


Parts Course Aggregate for One Part Cement
Per Cent. Voids in Coarse Aggregate
Per Cent. Excess Mortar in Coarse Aggregate
1.43 Parts, Fine Aggregate
NOTE
Cement factor based on 3.62 cu. ft. cement per barrel
Cement Factor
DIAGRAM Nº 3
30% EXCESS CEMENT
0% TO 30% EXCESS MORTAR
(Fine aggregate assumed to have 40% voids. Coarse aggregate 20% to 50% voids)

DIAGRAMS FOR THE DETERMINATION OF A SUITABLE CONCRETE MIXTURE

[Prepared by William B. Hunter.]

From this table it will be seen that concrete proportioned on the basis of a given percentage of excess gives uniform results as to the quantity, the proportions and the cement factor varying with the percentage of voids in the aggregates. Whereas, with arbitrarily fixed proportions, the quality of the concrete and the cement factor varies with the per cent. of voids in the aggregates.

Using Methods 2 and 3 (fixed proportions and fixed cement factor, respectively) proportions are usually used which in many instances give mixtures much richer than necessary, in order to guard against getting inferior results from time to time when the aggregates run bad.

The diagrams submitted are merely illustrative of the principle involved and are not necessarily expected to meet the requirements of any particular class of work, although the 20% excess diagram would probably give as good results as a 1 : 1½ : 3 mixture or a cement factor of 2, and would in most cases require less cement.

USE OF DIAGRAMS

Example 1—To find proportions to give 20% excess cement and mortar after filling voids in fine and coarse aggregate respectively, when voids in fine aggregate are say 40% and in coarse aggregate are 46%. On Diagram 1 on the left side find the line representing 40% voids in fine aggregate: follow this line to its intersection with the curve marked "parts of fine aggregate"; from this intersection follow up to the scale marked "parts of aggregate"; this gives 1.67 parts of fine aggregate.

On the line for 40% voids in fine aggregate follow to the right to the intersection of this line with curve for 46% voids in coarse aggregate; from this intersection again follow up to the scale of "parts of aggregate." This gives 3.03. The proportions are then 1 : 1.67 : 3.03.

To find the cement factor: Read on cement factor scale directly below the last found intersection, and we have cement factor 2.06+.

Diagram 2 is used in the same way as Diagram 1.

Example 2—To find proportions for 30% excess cement and 10% excess mortar, with the voids in aggregates the same as above, i.e., 40% and 46% respectively, use Diagram 3. The proportion of fine aggregate is constant in this diagram at 1.43. To find parts of coarse aggregate: On the left side of diagram on line marked "per cent. of voids in coarse aggregate" find horizontal line for 46% voids; follow this line to the right to its intersection with curves for 10% excess mortar; from this intersection go to the top of the diagram to the scale of parts of aggregate for one part cement; this will give 3.31. The proportions are then 1 : 1.43 : 3.31.

For the cement factor: from the intersection of the 46% void line with the 10% excess curve, follow parallel to the cement factor curves and read the cement factor—2.04+ on the cement factor scale.

METHOD OF COMPUTATION

In advocating the employment of the percentage of voids contained in aggregates as an agency in determining the proportions of aggregate to the cement in concrete, the writer is aware that he is proposing a method which has been cast aside by some of the concrete experts. Notwithstanding, he believes that the method herein described is sound in theory and practicability. The writer would further state that in the preparation of the accompanying diagrams he has neglected some small indeterminate coefficients which would not materially affect the results, but which would considerably increase the labor of preparation.

The basis of the computation follows:

1. The effect of the amount of water required to give the mixture a proper consistency in increasing or decreasing the volumne is neglected.

2. For the purpose of volumetric determination the

gross volume of the cement is considered as the absolute volume.

3. The volume obtained from given proportions is assumed to be the *gross* volume of cement and the *absolute* volumes of the aggregates.

4. The volume of one barrel of cement is considered to be 3.62 cu.ft.

The principal effect of these assumptions is that the cement factors are only approximate, but are believed to be close enough for all practical purposes, and inasmuch as all coefficients are more or less unreliable unless based on experiments with the particular ingredients to be used, it seems best to use none.

Some Radical Reforms in the Conduct of Patent Litigation

By Gilbert H. Montague*

The chief criticism directed against the existing patent system has always been that in patent litigation testimony was ordinarily taken, not in court before a judge, whose good offices could be relied upon to expedite the trial, but out of court before an examiner, who was powerless to control the length of the examination or the prolixity of the testimony. Thus, it was possible to expand the testimony to unseemly lengths and impose intolerable delay, and well-nigh prohibitive expense upon the weaker litigant.

How far this grievance has underlain the entire agitation for radical changes in the patent laws appears from the report submitted to the House of Representatives last August accompanying the Oldfield Patent Revision Bill (H. R. 23,417):

> The time and money wasted in having testimony given orally before the examiner who does not listen to it then written out by the reporter and ultimately printed for submission to the judge who often does not have time to read all of it is necessarily great. Days or weeks may be honestly consumed with the introduction of evidence on points which the judge, if present, would declare to be clearly immaterial or if material to be adequately established in the absence of evidence to the contrary.
>
> The fact that no means exists for determining the materiality, propriety or necessity of introducing material evidence in the course of the taking of testimony results inevitably in great waste of time and money. But the fact that the proceedings before the examiner are practically uncontrolled affords also unequaled opportunity for serious abuse of legal processes—opportunities which are unfortunately availed of all too frequently. The immediate result is often a triumph of might over right followed by a rankling sense of injustice and a deep-seated contempt for the law.

Finally, there was always the possibility that even after this enormous bulk of testimony had eventually been passed upon by the court and a decree made thereon, the Appellate Court might reverse the decree and send the whole cause back for a new trial involving a repetition of the same tedious performance.

This was the condition confronting Chief Justice White, of the United States Supreme Court, when he and his colleagues set out last spring to revise the Rules of Practice for the Courts of Equity of the United States. How resolutely the Supreme Court dealt with this condition appears from the new rules themselves.

Rule 46, relating to trials, requires that testimony shall, except in extraordinary cases, be taken in open court and reads as follows:

> In all trials in equity the testimony of witnesses shall be taken orally in open court, except as otherwise provided by statute or these rules. The court shall pass upon the admissibility of all evidence offered as in actions at law. When evidence is offered and excluded, and the party against whom the ruling is made excepts thereto at the time, the court shall take and report so much thereof, or make such a statement respecting it, as will clearly show the character of the evidence, the form in which it was offered, the objection made, the ruling, and the exception.

What may be expected of this rule is intimated in the report above quoted, submitted to the House of Representatives last August:

> The evidence should be introduced in open court before the judge who is to hear the argument as soon as the evidence is concluded. The judge is thus in a position to deal promptly and effectively with the whole proceeding. The amount of evidence introduced is greatly lessened because immaterial issues, irrelevant inquiries, impertinent questions may be ruled out. The value of the evidence also may be properly determined because the judge hears and sees the witnesses and may infer from their behavior, intonation, and appearance, as well as from the words spoken, their relative credibility.
>
> Litigation which now takes years would, through such a trial, be disposed of in as many months, and where desired could even be disposed of in a few weeks. In the presence of an able judge armed with power to exclude evidence or to enforce its production, and instructed, through his continued presence, in the merits of the controversy, that abuse of the legal process which has become the scandal of the patent practice and one of the most potent instruments of oppression would cease. Justice, swift and more certain, would prevail.

According to Rule 47, no exception to the foregoing rule will be allowed except in very unusual cases, incontrovertibly proved under oath, and even then only under the strictest conditions as to the time within which depositions must be taken and filed. The rule is very explicit:

> The court, upon application of either party, when allowed by statute, or for good and exceptional cause for departing from the general rule, to be shown by affidavit, may permit the deposition of named witnesses, to be used before the court or upon a reference to a Master, to be taken before an Examiner or other named officer, upon the notice and terms specified in the order. All depositions taken under a statute, or under any such order of the court, shall be taken and filed as follows, unless otherwise ordered by the court or judge for good cause shown; those of the plaintiff within sixty days from the time the cause is at issue; those of the defendant within thirty days from the expiration of the time for the filing of plaintiff's deposition; and rebutting depositions by either party within twenty days after the time for taking original depositions expires.

Rule 48 deals directly with the sorest subject of patent practice, namely, the testimony of expert witnesses in patent and trade-mark causes.

> In a case involving the validity or scope of a patent or trade-mark, the district court may, upon petition, order that the testimony in chief of expert witnesses, whose testimony is directed to matters of opinion, be set forth in affidavits and filed as follows: those of the plaintiff within 40 days after the cause is at issue; those of the defendant within 20 days after plaintiff's time has expired; and rebutting affidavits within 15 days after the expiration of the time for filing original affidavits. Should the opposite party desire the production of any affiant for cross-examination, the court or judge shall, on motion, direct that said cross-examination and any re-examination take place before the court upon the trial, and unless the affiant is produced and submits to cross-examination in compliance with such direction, his affidavit shall not be used as evidence in the cause.

The result of these rules, in spite of the shortening of litigation which they will effect, will be to increase the labors of the judges. In districts where the court calendars are already crowded, this may make necessary the creation of additional judgeships. No one, least of all any litigant or lawyer having to deal with the courts,

*Counsellor at Law, 40 Wall St., New York City.

will deplore this possibility. Indeed, simply as an additional argument to induce Congress to create additional judgeships in many of the districts, the new rules will justify themselves. When the attention of Congress is thus directed to the subject, it is confidently hoped that it will see also the necessity of providing at the same time for a Court of Patent Appeals, to hear appeals in patent causes from the nine Circuit Courts of Appeal, over which the Supreme Court, under the existing practice in respect to patent causes, has scarcely any appellate powers or opportunity to correct or reconcile conflicting decisions. These improvements in the courts dealing with patent matters have become more imperative, and probably nearer to accomplishment, as the result of the new rules.

The zeal of the Supreme Court of the United States to prevent prolixity of testimony and undue expansion of the record appears throughout the new rules.

Depositions before an examiner are expressly permitted to be in narrative form instead of in question and answer (rule 49). No transcript of evidence before the examiner can include argument or debate (rule 51). "The evidence to be included in the record (on appeal)," says rule 75, "shall not be set forth in full, but shall be stated in simple and condensed form, all parts not essential to the decision of the questions presented by the appeal being omitted and the testimony of witnesses being stated only in narrative form, save that if neither party desires it, and the court or judge so directs, any part of the testimony shall be reproduced in the exact words of the witness."

The determination of the Supreme Court to stamp out the common devices by which patent litigation has heretofore been made burdensome is notably expressed in Rule 76:

> In preparing the transcript on an appeal, especial care shall be taken to avoid the inclusion of more than one copy of the same paper and to exclude the formal and immaterial parts of all exhibits, documents and other papers included therein; and for any infraction of this or any kindred rule the Appellate Court may withhold or impose costs as the circumstances of the case and the discouragement of like infractions in the future may require. Costs for such an infraction may be imposed upon offending solicitors as well as parties.

The way of the procrastinator in patent litigation will hereafter be hard.

"After the time has elapsed" says rule 56, "for taking and filing depositions under these rules, the case shall be placed on the trial calendar. Thereafter no further testimony by deposition shall be taken except for some strong reason shown by affidavit. In every such application the reason why the testimony of the witness cannot be had orally on the trial, and why his deposition has not been before taken, shall be set forth, together with the testimony which it is expected the witness will give."

"After a cause shall be placed on the trial calendar," says rule 57, "it may be passed over to another day of the same term, by consent of counsel or order of the court, but shall not be continued beyond the term save in exceptional cases by order of the court upon good cause shown by affidavit and upon such terms as the court shall in its discretion impose. Continuances beyond the term by consent of the parties shall be allowed on condition only that a stipulation be signed by counsel for all the parties and that all costs incurred theretofore be paid. Thereupon an order shall be entered dropping the case from the trial calendar, subject to reinstatement within one year upon application to the court by either party, in which event it shall be heard at the earliest convenient day. If not so reinstated within one year, the suit shall be dismissed without prejudice to a new one."

Finally, the probability of having to endure a new trial simply because the Appellate Court may reverse the decree on the ground that the Trial Court improperly excluded certain evidence is reduced to a minimum.

"If the Appellate Court" says rule 46, "shall be of opinion that the evidence should have been admitted, it shall not reverse the decree unless it be clearly of opinion that material prejudice will result from an affirmance, in which event it shall direct such further steps as justice may require."

Under this rule the Appellate Court, instead of directing a new trial involving a repetition of the tedious performance of assembling all the proofs and witnesses and presenting the evidence again before the Trial Court, may let the decree stand, if it appears that no material prejudice resulted from excluding such evidence; and if it is satisfied that prejudice did result from excluding such evidence, it may simply direct that the lower court open the case for the sole purpose of receiving such evidence together with such further evidence as may be offered in opposition thereto, and then reconsider its decision in the light of such new evidence.

These rules went into effect February 1, 1913. Alone, and without the necessity of any amendment in the law, they have removed what probably has been the chief ground for the recent criticism of the patent system. Taken in conjunction with the report of the President's Commission which investigated the Patent Office, they point the way to improvements which, without any act of Congress, can be effected, in the administratiion of the patent laws, and illustrate the futility of seeking, by fundamental changes of the patent system and radical abridgment of the rights of patent owners, to accomplish reforms that so easily and so completely can be attained without resort to legislation.

❋

A Very Heavy Truck Load was hauled through New York City streets by a motor truck on Mar. 18. The hauling was done by a La France hydraulic transmission motor truck, which uses the Manly variable-speed hydraulic drive, the advantages of which in perfect speed control and exertion of a slow powerful steady pull in starting are similar to those of the Pratt hydraulic transmission described in our issue of Oct. 31, 1912. The load to be hauled consisted of a door frame for the safety deposit vaults to be installed in the basement of the new Clearing House Building. The door frame was made by the York Safe & Lock Co., and was delivered on a lighter at Pier 11, East River. The frame was 7 ft. 6 in. wide, 9 ft. long, and weighed 52,600 lb. It was loaded upon a very substantial four-wheel wagon, which weighed empty 16,400 lb. A span of horses were attached to this wagon to guide the pole and steer the wagon, but the traction was furnished by a La France hydraulic motor truck, weighing 4½ tons, which was itself loaded with five steel plates for the vault weighing together 12,100 lb. The total load to be moved, therefore, was 90,100 lb., or substantially 45 tons. The load per wheel on the truck carrying the door frame was 17,250 tons. The Street Department refused to permit the load to be hauled through Wall St. on account of possible injury to pavement. It therefore proceeded to its destination by way of Front St. to South Ferry and then up Whitehall St. and Broadway. The truck was hauled up the 4½% grade at Bowling Green without difficulty, and to demonstrate its starting power was stopped on this grade and started again. The load was moved without injury to the pavement, except the breaking of one manhole cover on Whitehall St.

A New Locomotive Testing Plant*

By Edward C. Schmidt†

SYNOPSIS—Determinations of the efficiency of locomotive performance can be made to best advantage for scientific accuracy in a laboratory or testing plant, where the load and speed can be adjusted and varied or kept uniform at will, and where the engine is free from the varying and disturbing influences of weather, track conditions and traffic conditions. Road tests, of course, still have their uses, but there are many tests and investigations which cannot be made satisfactorily with an engine on the road. In the laboratory, the engine is anchored by its drawbar to a dynamometer, and its driving wheels rest on wheels which are revolved by the friction of the engine wheels. Hydraulic brakes applied to the axles of the supporting wheels enable the load or resistance to be applied or varied as desired. This country has taken the lead in the construction and use of testing plants of this kind, and three engineering colleges include them among their equipment. The accompanying article describes the latest of these, which presents some special features of novelty and importance.

❖

The locomotive testing plant has placed at our disposal a means for studying the locomotive which has made good the deficiencies of road testing. The first locomotive testing plant was built 21 years ago at Purdue University. It was designed by Dr. W. F. M. Goss, who was at that time in charge of the schools of engineering at that institution. Not the least of the good influences of this plant is the encouragement which its success has offered to other experimenters to establish similar laboratories. At present there are four such testing plants in this country and two in Europe.* An addition to the small number of existing plants is of interest, and the present article describes the new plant of the University of Illinois, which will be put in operation in April. The Illinois legislature at its last session included among its appropriations for the university $200,000 for new buildings for the College of Engineering, and it was decided to use this for a transportation building and a locomotive laboratory for the department of railway engineering. The plant has been designed with the intention of making it suitable to test new designs of locomotives as they appear, in the confidence that the railways and builders would be willing to keep upon the plant locomotives of recent design, concerning whose performance information is desired. Figs. 1 and 2 show the general arrangement of the plant.

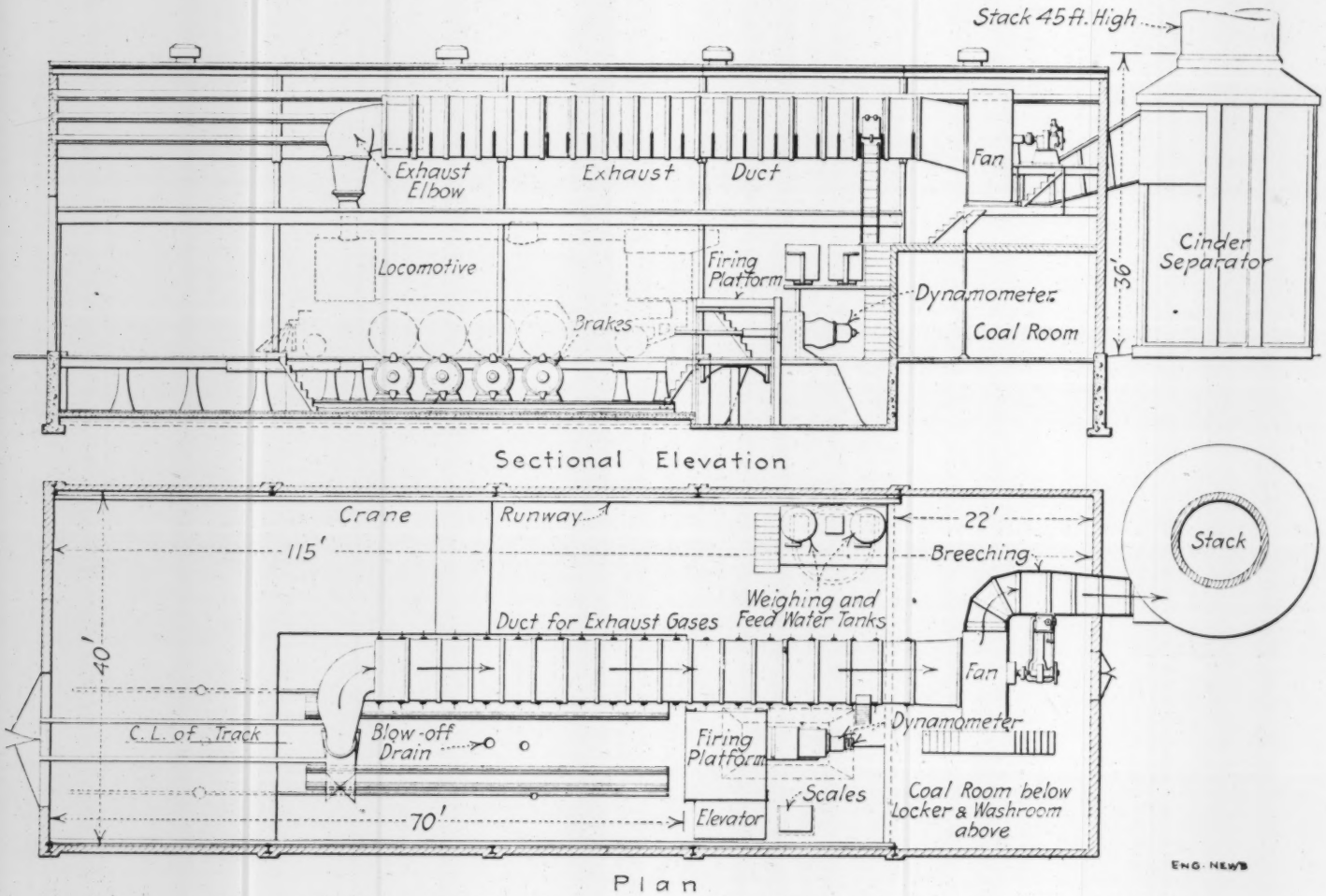


Fig. 1. Sectional Plan and Elevation of the New Locomotive-Testing Plant at the University of Illinois

*Paper before Western Railway Club, Chicago, Mar. 18, 1913.

†Professor of Railway Engineering, University of Illinois, Urbana, Ill.

*The Purdue plant, erected in 1891, was followed in 1894 by a temporary plant, at South Kaukauna, Wis., on the Chicago & Northwestern Ry., designed under the direction of Mr. Quayle. This was succeeded in 1895 by a permanent plant, designed by Mr. Quayle and erected at the C. & N. W. Ry. shops in Chicago. In 1899, Columbia University, having been given a locomotive by the Baldwin Locomotive Works, provided for a testing plant which is erected in the mechanical engineering laboratory. In 1904, the Pennsylvania R.R. installed at the St. Louis Exhibition what was at that time the largest and most elaborate plant yet built. This later was removed to Altoona, Penn., where it has been in almost constant operation since. In 1904, there was also erected in the Putiloff Works at St. Petersburg, Russia, a similar plant designed by M. V. Coloboloff and S. T. Smirnoff. The following year there was erected in England a plant under the direction of Mr. Churchward of the Great Western Ry., at the Swindon works of that company.

SUPPORTING WHEELS AND HYDRAULIC BRAKES

Any locomotive testing laboratory consists essentially of (1) a means for so supporting the locomotive that its wheels may be rotated and that the power developed may be absorbed and either dissipated or transferred, (2) a means for anchoring the locomotive when so mounted and for measuring the tractive effort developed, (3) means for supplying and measuring coal and water, and (4) means for disposing of the gases and exhaust steam. The supporting mechanism in this plant (as in all others) consists of wheels whose position may be varied to conform to the spacing of the locomotive's driving wheels. The supporting wheels are 52 in. diameter, provided with plain tires and mounted on 11⅛-

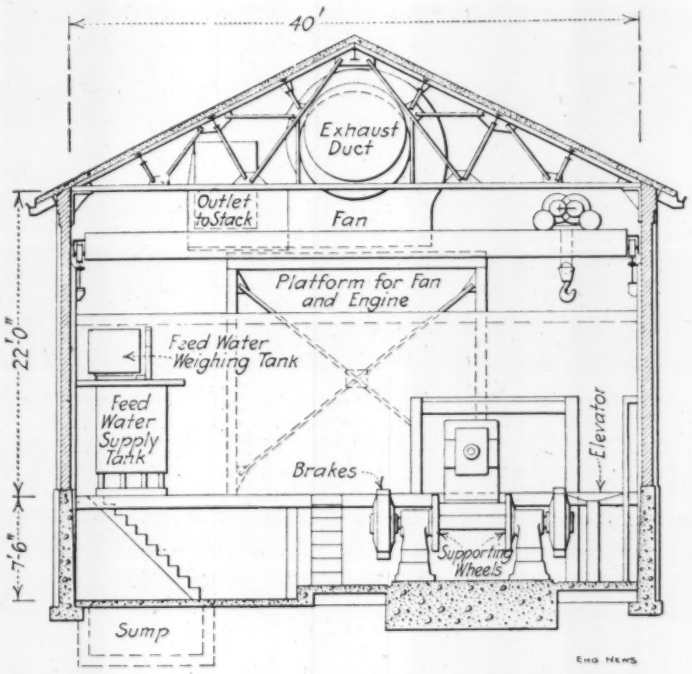


FIG. 2. CROSS-SECTION OF LOCOMOTIVE-TESTING PLANT

in. axles, the axles and tires being of heat-treated carbon steel.

The use of 52-in. supporting wheels involves rotating speeds as high as 500 r.p.m. in testing high-speed locomotives. Such speeds may give rise to difficulty in the operation of the bearings although they have been designed with regard to these conditions. However, provision has been made (in the design of the bearing pedestal) for using 72-in. wheels, if it proves desirable. The axles are supported at each end just beyond the wheels, in bearings 9½x20 in., which are provided on the under side of the journal only. These bearings are carried in self-aligning shells which are supported in pedestals of exceedingly heavy construction. Oil is provided at two points in the bearing cap, where it is supplied under head from an elevated supply tank. The bearing pedestals rest on massive cast-iron bed plates which run the entire length of the testing pit, and as the bolt heads are held in slots running the length of the bed, the pedestals may be shifted to any desired position on the bed.

Hydraulic brakes on the axles provide means for absorbing the power developed at the driving-wheel rim, as shown by the cross-section in Fig. 2. These are of the type used in all other American testing plants, and were designed by Prof. G. I. Alden, of Worcester, Mass., under general specifications prepared by the designer of the plant. One of these brakes is mounted on each end of each supporting axle. Each brake (Fig. 3) consists essentially of three cast-iron disks, A, which are keyed to the supporting axle, and which rotate between water-cooled copper diaphragms B, carried in a stationary casing C. The cast hub D and the three disks form an integral rotating element which is keyed to the axle and turns with it. The casing and its diaphragms are prevented from rotating by means of links attached to the bed plates. The diaphragms form within the casing three compartments within which the cast-iron disks rotate. The surfaces of the disks and of the diaphragms are lubricated by oil fed in at the periphery of the disks and taken off at the hub. The diaphragms form also within the casing four water compartments which have no communication with those within which the disks rotate. Water is fed into these water compartments at E, and is taken off at F. The pressure existing in these water spaces may be varied at will by means of suitable valves in the brake piping.

The operation of the brakes is as follows. Power received from the driving wheels of the locomotive is transmitted through the supporting wheels and axle to the cast-iron brake disks; these in turn transmit it by friction to the surfaces of the copper diaphragms against which they rub. By varying the water pressure, the friction between the disks and the diaphragms may be varied in accordance with the amount of power to be absorbed. The entire power of the locomotive is thus dissipated at the surface of the diaphragms and carried away as heat in the water which circulates through the brakes. Each brake is designed to develop a resisting torque of 18,000 lb.ft., which is more than is likely to be transmitted to it by the most heavily loaded locomotive driver.

The above machinery, which serves to support the locomotive and to absorb its power, is all carried on a slab of reinforced concrete 93 ft. long and 12 ft. wide, varying in thickness from 3½ ft. at the front to 5 ft. at the rear. It is surmounted at the rear end by a pyramidal pedestal which serves as the anchorage for the dynamometer.

TRACTION DYNAMOMETER

The locomotive is anchored by a massive drawbar to a dynamometer of the Emery type, which consists essentially of a weighing head and a weighing scale. Within the head is an oil chamber with a flexible wall, which receives and balances any force transmitted from the locomotive. The pressure of the oil in this chamber varies with the load and is transmitted through a copper tube of small bore to a similar smaller oil chamber, the pressure within which moves the beam of a substantial but very sensitive scale. The force transmitted to the dynamometer is thus weighed. In design this instrument is very similar to that of the original dynamometer furnished for the Purdue university plant. Its capacity, however, is about four times as great, namely 125,000 lb.* Up to this limit it will measure with great accuracy any force transmitted to it from the locomotive. One feature of special interest is that the adjustment of the poise weight on the scale beam is accomplished automatically. This has permitted (for the first time in this type of instrument) the development of a de-

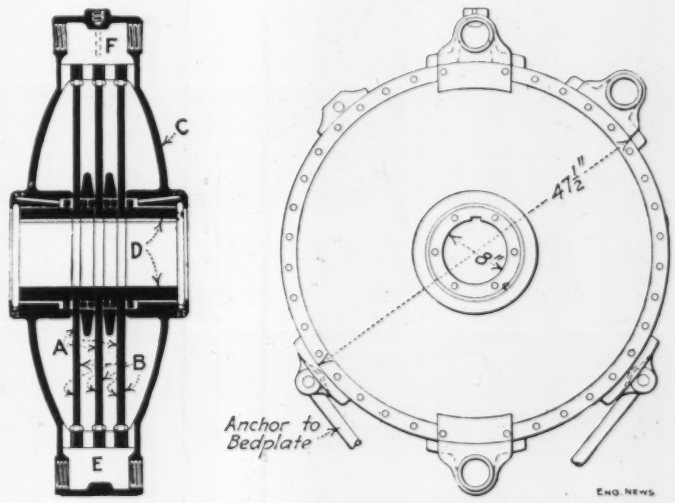


FIG. 3. THE ALDEN HYDRAULIC ABSORPTION BRAKE FOR LOCOMOTIVE-TESTING PLANTS

vice whereby the amount of the force weighed on the scale is autographically recorded.

The capacity of this instrument is about 15,000 lb. in excess of the greatest tractive effort which could be imposed upon it by even the most powerful Mallet locomotive now in existence. The plant can test the largest of these Mallet engines; and at the same time all the equipment and the building itself have sufficient margin in size and capacity to allow for a very considerable increase in size, weight and power of locomotives.

DETERMINING EXHAUST GASES AND CINDERS

In providing means for disposing of the exhaust gases, new problems were presented and new solutions have been reached. In view of the importance of determining accurately the total fuel lost in the exhaust gases, it was de-

*The maximum capacity of the dynamometer used in the Pennsylvania R.R. plant at Altoona is 80,000 lb.

cided to try to incorporate some means for entrapping all of the solid matter contained in the gases passing from the smoke-stack. This purpose has been served previously by collecting in a sampling tube the solid matter which passes a small section of the exhaust-gas stream, and pro-rating the loss of solid fuel thus determined over the entire stream section. This method is not always convenient, and under certain conditions its results are open to doubt.

A spark trap or cinder collector which would pass the total volume of gas and exhaust steam from the largest

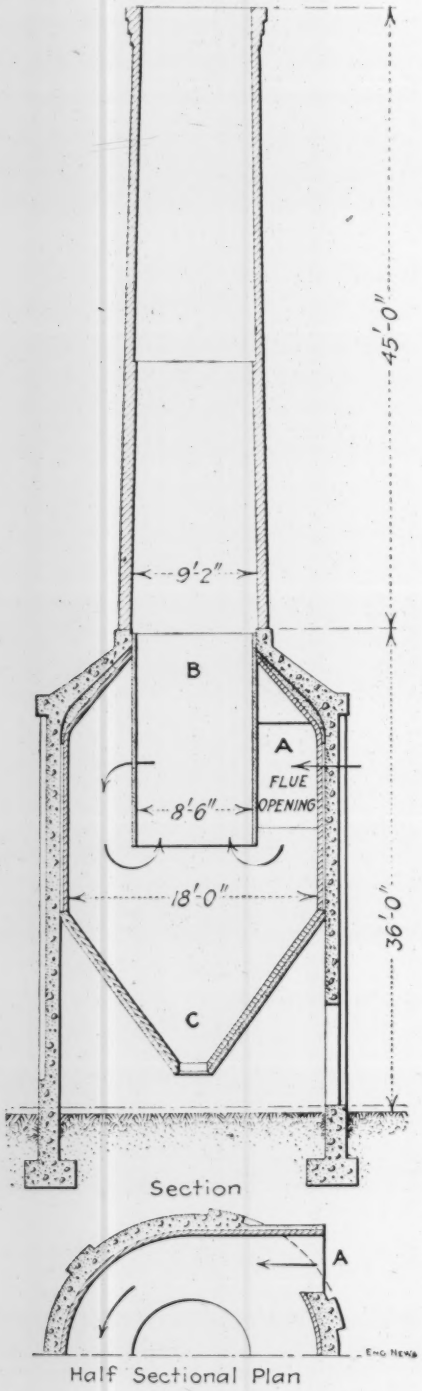


FIG. 4. STACK AND CINDER-COLLECTING CHAMBER

modern locomotive when working at high power would be too large to be located conveniently within the building. A second fundamental consideration in designing the exhaust system was the necessity of providing a stack of sufficient height to insure that the gases would be discharged at such a height as to prove inoffensive to occupants of neighboring residences and university buildings. It was decided that this would require a stack about 8 ft. diameter and at least 80 ft. high. Further study made it apparent that these two features could be embodied in one structure. This has been accomplished by the combined cinder-separator and smoke-stack which is shown in Fig. 4 and is located outside of the laboratory.

The exhaust gases as they emerge from the locomotive stack are discharged into a steel exhaust elbow which carries the gases up and over to a horizontal duct running through the roof trusses. The gases are drawn through this elbow and duct by an exhaust fan. Probably the heaviest cinders will be dropped in this duct, but the velocity within it is such that all but the heaviest particles will be carried through the fan. Whatever does accumulate here may be removed through traps provided in the bottom of the duct, and weighed.

The gases and solid matter passing through the fan are delivered by a breeching or flue to the separator. They enter this at A, and in order to leave they must pass downward and around the sleeve B. In so doing they are given a whirling motion which causes the cinders to move toward the wall, along which they drop to the hopper C, while the gases pass downward and out to the stack through the mouth of the sleeve. The cinders collecting at the bottom of the hopper are drawn off and weighed. This separator is surmounted by a 45-ft. radial-brick stack.

The corrosive nature of the mixture of exhaust gas and steam has made it necessary to avoid the use of metal. The exhaust elbow within the building necessarily has been made of steel, and will need occasionally to be renewed. The duct and fan breeching, however, are of asbestos board which will resist corrosion. The duct is 7 ft. diameter, and made up of separate sections so that its length may be varied. The fan has a runner 6 ft. diameter, and will pass, at maximum speed, 140,000 cu.ft. of gas per minute. The breeching has a minimum cross-sectional area of about 24 sq.ft.

The outer shell of the separator is built of reinforced-concrete, lined with hard-burned red brick (as is the hopper). Between the lining and the shell is a 2-in. air space to protect the shell from undue heating. Any leakage of gas into this space is vented to the outside air through openings in the shell, which serve also to circulate cool air through the air space. The inside sleeve and hopper are of reinforced concrete. The stack is unlined, but is laid up in acid-proof cement.

[We are informed by Dean W. F. M. Goss that the first locomotive to be tested was received at the plant Apr. 11. This is No. 958 of the Illinois Central R.R.—a modern consolidation-type freight engine with eight drivers, weighing 182 tons.—Ed.]

Repairs to a Reinforced-Concrete Chimney

BY C. E. SMITH*

In 1903 a reinforced-concrete smoke-stack was built for the power house of the Kansas-Missouri Elevator Co., at Kansas City, Mo. The smoke-stack has a total height above the ground of 160 ft. The lower 60 ft. is composed of a double shell and the upper 100 ft. of a single shell, the entire chimney being reinforced horizontally and vertically by mild-steel T-bars. The horizontal bars are 1x1x⅛-in. bent circular and the vertical bars are 1¼x1¼x¼ in.

The inner shell of the lower portion is 4 in. thick and has an internal diameter of 5 ft. It is reinforced by horizontal circular T-bars 18 in. apart and vertical T-bars 16 in. apart. The outer shell of the lower portion is separated from the inner shell by a 4-in. air space. The outer shell is 8 in. thick and has an external diameter of 7 ft. 8 in. It is reinforced by horizontal circular T-bars 3 ft. apart and vertical bars spaced approximately 3 in. apart at the bottom of the chimney, the space increasing by decreasing the number of bars until the bars are 6 in. center to center for the upper portion of the outer shell. At the top of the double-shell section of the chimney the inner and outer shells merge, vents being left in the inner shell for purposes of expansion.

Above this portion extends 100 ft. of chimney having a single shell with an external diameter of 6 ft., the thickness of shell being 6 in. for the lower 45 ft., 5 in. for the next 30 ft. and 4 in. for the top 25 ft. The horizontal reinforcement consists of circular T-bars 3 ft. apart

*Bridge Engineer, Missouri Pacific Ry. Co., St. Louis, Mo.

throughout the entire height and vertical reinforcing bars approximately 3 in. center to center near the bottom of the single shell and 18 in. center to center at the top of the chimney.

On account of the extremely thin shell, especially near the top, the outstanding edges of the reinforcing bars come very close to the surface of the concrete.

In the fall of 1912 it was noticed that during severe winds the chimney gave out a grinding sound and chunks of concrete fell from its outer surface, creating considerable alarm among the employees having duties near the base of the stack.

Close inspection from the iron ladder attached to one side of the chimney and by telescope of the remaining surface, indicated that the entire upper portion, 100 ft. high, was cracked vertically and horizontally into a large number of rectangular slabs, the cracks being located along the lines of the reinforcement and that the cracks

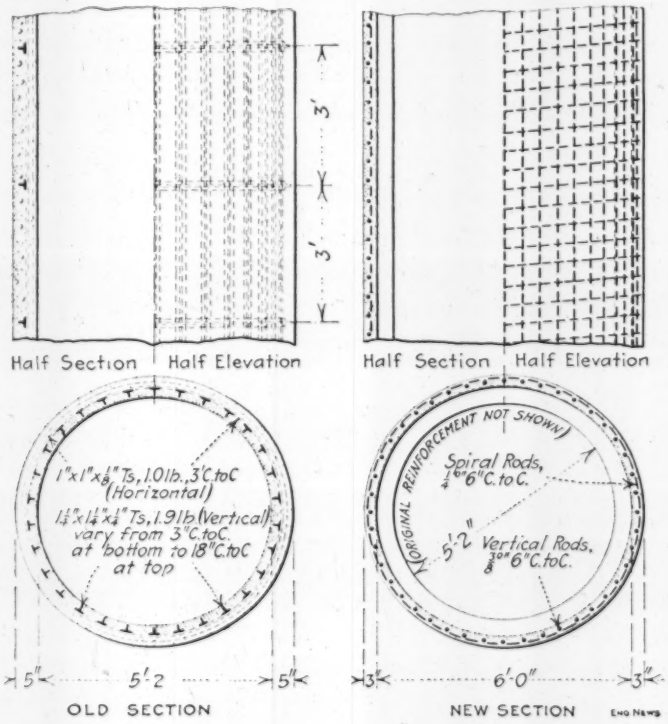


FIG. 1. DETAILS OF UPPER PORTION OF CHIMNEY BEFORE REPAIRS

FIG. 2. DETAILS OF UPPER PORTION OF CHIMNEY AFTER REPAIRS

would soon become so large as to permit corroding influences to reach the thin reinforcing members, which would have resulted in the early collapse of the chimney.

On account of the fact that the elevator is almost continually busy and for the further reason that the necessity for the repairs became apparent at a very busy season, it was decided to make repairs without taking the chimney out of service.

The upper edge of the chimney had deteriorated so badly and the concrete there was so shattered and loosened that it was considered unsafe to suspend a swinging platform from the top, so a temporary timber staging resting on the ground was erected around the chimney reaching to the top and the bracing was so arranged that platforms could be placed at intervals of about 6 ft. From these platforms a very careful examination of the entire chimney was made.

It was found that the cracks were much larger and more open, and the chimney in much worse condition than was indicated by the preliminary examination. In many places the reinforcement was entirely exposed and had already deteriorated considerably by corrosion. The ease with which concrete was knocked off the reinforcement by blows of a small hammer indicated that T-bars are entirely unsuited to use for this purpose in thin layers of concrete. It was apparent that the expansion and contraction of the chimney, together with the strains caused by the wind, cracked the concrete along the lines of the horizontal circular bars and that the sections later cracked along the vertical bars. The outstanding edges of the T-bars were in many places only ½ in. from the surface of the concrete. It is difficult to understand why deformed rods were not used.

It was decided to cover the entire 100-ft. upper portion with a reinforced-concrete shell 3 in. thick, and repairs were started immediately. As there were no signs of failure in the lower double portion, no repairs were made, but it was given a coat of grout applied as a paint, both to secure a uniform appearance and to make the surface better able to resist the adverse weather conditions.

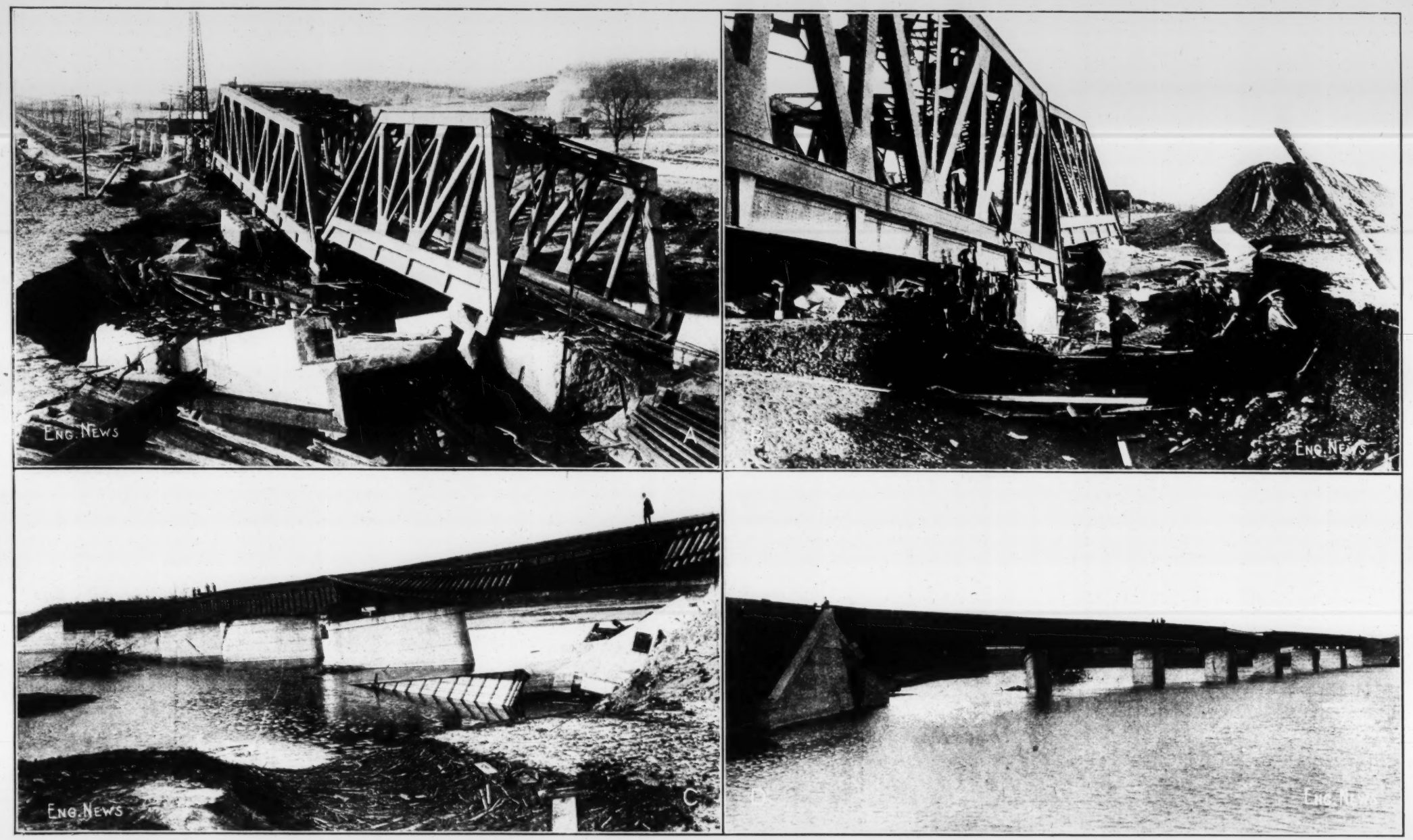
Before placing the reinforced-concrete shell all loose concrete that could be readily dislodged by a hand hammer was removed, the cracks and exposed reinforcement were brushed clean and all openings and cracks filled with grout. Deformed rods ⅜ in. in diameter were placed vertically 6 in. apart entirely around the chimney, the lower ends of these rods being set and grouted in holes drilled in the outer shell of the lower portion of the chimney. Deformed bars ⅜ in. in diameter were also bent around the chimney to form a spiral from top to bottom with 6-in. pitch. The rods were placed as nearly as possible 1½ in. from the outer surface of the chimney.

Four lifts of steel forms were used. Each lift consisted of two half-cylinders of No. 10 steel plates 3 ft. high, stiffened top and bottom and at the ends by small angle irons in which bolts were placed to hold the sections together. The inside diameter of the forms when set up was 6 ft. 6 in.

The concrete was mixed "dry," in order to permit early removal of the forms, and was thoroughly tamped in place. Most of the concrete was placed when the temperature was slightly below freezing but no precautions were taken to prevent freezing. As the chimney was in use throughout the work, having an external temperature of about 80° F., the new concrete set rapidly and permitted the removal of the forms after 24 hours which permitted the placing of about 12 ft. in height each day.

The former weight of the chimney was 467,000 lb. and the overturning moment of the wind about the base, assumed at 50 lb. per sq.ft., 2,293,500 ft.-lb., making the maximum pressure on the base 2300 lb. per sq.ft. The reinforcement added approximately 75,000 lb. weight which increased the base pressure to 2600 lb. per sq.ft. As the base is 20 ft. square, 10 ft. deep in the ground, and no settlement had ever been experienced, no fears were felt of the stability of the chimney under the increased load.

The work was carried out on a force account basis under the direction of the engineering force of the Missouri Pacific Ry. Co., by Flanagan Brothers, of Kansas City, Mo., and cost about $2500.



A. Bridge over canal and electric line, looking NE from embankment beyond south abutment. B. Same bridge, looking S or downstream from a point near north abutment.
C. Miami River Bridge, south of canal bridge. View looking E, showing north or upstream face of bridge. D. Downstream side of same bridge, seen looking NW.

TWO RAILWAY BRIDGES DESTROYED BY THE MIAMI FLOOD. (C. C. C. & ST. L. RY. CUTOFF SOUTH OF MIAMISBURG, OHIO)

Two Heavy Railway Bridges Wrecked by the Miami River

The four views on the opposite page illustrate strikingly one important element of the recent Central States floods—the amazing extent of bridge destruction. Two structures of most modern design are shown, both completely wrecked. The substructures are washed out, or underscoured and tipped, and the excellence of the superstructures then could not save them. To get a general idea of what the flood period meant throughout Ohio and Indiana it is only necessary to multiply these pictures several scores of times, and to realize that practically all railways south of the Erie-Ohio divide were reduced to the condition of that shown.

The cutoff of the C., C., C. & St. L. Ry. on which these bridges occur was mentioned in our last issue, and a sketch map was shown. The upper two pictures on the opposite page show the bridge over the Miami & Erie canal, the Ohio Electric Ry. and a highway, just south of Miamisburg, Ohio; the lower views show the Miami River bridge some distance south (the northerly of the two river crossings of the cutoff). While the river bridge has 7 spans, it is on skew location, so that the clear channel width is much less than the bridge length. The piers tipped upstream, and the broken abutment, prove the intensity of current action. At the canal bridge (upper views) the scouring action is even more evident; this bridge is at a distance of a quarter mile or more from the river.

⁂

The Status of Engineering*

Engineers as a body are duly esteemed by others, and are themselves proud of their profession. It is only when they come asking for recognition that anyone is in the least degree inclined to look down on them, and then it is their attitude rather than themselves that merits contempt. The status of engineering as a profession is secure, the status of the individual members of the profession seems to be more doubtful, and the reason assigned is that men with neither the education nor the experience necessary to a proper professional standard are yet recognized by the public as engineers.

We may pass over the complaint that the word "engineer" is used to include artisans in engineering works. There are many ambiguities in the English language which are yet easily recognized, and no one hearing of "an engineers' strike" supposes that Great George Street has closed its doors, nor thinks that the engineer responsible for the design and construction of a reservoir is merely a skilled workman.

The complaint, however, of incompetent and defective education among young engineers is more plausible, and to whatever extent it may be true, to that degree does it tend to lower the status of engineers, if not of engineering. The difficulty is said to arise from the fact that the engineering profession draws its recruits from every class of the community, and that the social status of a profession depends on the class from which its recruits are drawn. The remedies proposed are State recognition and a State examination sufficiently stringent to exclude the incompetent.

Now if it be true that the lowering of the status is due to an inordinate leavening from the lower strata of society, no State recognition can alter that. Status is an individual matter dependent on birth, character, and upbringing; and the State cannot control the private judgment of the community nor force it to call a sow's ear a silk purse.

State examinations would do something to keep the profession select, as it keeps the Indian Civil Service and the Army select, not by raising the standard, for it lowers it, but by making the preparation for the examination too expensive for any but the well-to-do. It would keep out just those who should be let in easily, the men of brains and personal character sufficient to raise them from the ranks despite their lack of any liberal education.

It has been well said that the Stephensons could neither of them have passed the examination of the Institution of Civil Engineers. Men who rise from the ranks are likely to have sufficient sense and adaptability to make their own status, and to adopt, easily and naturally, the manners and conventions of their new surroundings.

But for men who are lifted from the ranks, State recognition can do nothing. Some have urged the adoption of trade-union methods to raise, not status, but salaries. We have always understood that trade-union methods aim at putting the good and bad worker as near as may be on an equality, and discouraging individual effort. But individual effort is the life-blood of engineering, and there can be no surer means of degrading the profession than to discourage it. By all means keep out the incompetent, but let the engineers themselves do it; not rely on the State, which means, in effect, on a number of men ignorant of engineering.

*Extracts from an editorial in the "Contract Journal," London, April 16

⁂

Notes on the Flood in the Lower Mississippi

By A. L. Dabney*

The maximum rate of discharge at Cairo in this year's flood is, in the writer's opinion, very nearly the same as in last year's. It is true that the stage at Cairo was 0.7 ft. higher this year than last, but it seems probable that less water escaped through breaks in the levees on the west side of the river near Cairo. Definite information on both these points is lacking, however.

Nearly all of the water that escaped through the breaks opposite Cairo returned to the river a short distance below, so that these breaks which gave some relief to Cairo gave much less relief to Memphis and points below.

It was estimated that last year's flood would have reached about 47.5 or 48 ft. gage height at Memphis if there had been no breaks. Indications are that it might have reached about 47 this year, even after the occurrence of the breaks near Cairo, had no breaks occurred in this vicinity.

The lower St. Francis levees were designed to withstand a stage of 42 or 43 ft. at Memphis, *and were only 60 per cent. complete by this standard*; yet they held the 1912 flood up to a stage of 45. Several breaks occurred in that district last year, when that stage was reached at Memphis, allowing about 2½ ft. of the flood crest to escape into the St. Francis Basin. Here was a *reservoir* just in the right place to lower the gage at Memphis. By filling several million acres to a depth of about 10 ft., the stage at Memphis was kept down these 2½ ft. The highest stage at Memphis last year was 45.3.

This year a stage of 46.5 was reached at Memphis. The crest of the flood had almost reached here before a break occurred that gave material relief at this point. The first break in the Lower St. Francis levees occurred on the afternoon of Apr. 8, at a point about 23 miles below Memphis. The gage at Memphis read 45.5 ft. when this break occurred. The rise of the river at Memphis was not materially interrupted by this break, an excellent illustration of the fact that an *outlet* will give little relief to points upstream beyond a very short distance.

The following afternoon, Apr. 9, during a heavy wind and rain storm, when the gage read 46.4, two breaks occurred in the St. Francis levee about 40 miles above

*Memphis, Tenn.

Memphis. I believe these last breaks would not have occurred, even with the heavy odds against the flood fighters, if the weather had not made it impossible to hold the laborers on the work.

The result of the three breaks was a fall at Memphis of about 2 ft. in the first 48 hours and 2½ ft. in the first 72 hours. The lower half of the St. Francis basin was an empty reservoir, in a very good place. After it was filled, there was still a stage at Memphis 4 ft. higher than was ever recorded before 1912.

Had the levees of the Lower St. Francis Levee District been 4 or 5 ft. higher than they were, they would probably have been held. Had they been 6 or 7 ft. higher with commensurate base, they would have been reasonably secure.

The St. Francis levees were reported by the Chief Engineer of that district *before the 1912 high water*, to be only 60% complete; yet their giving way under 4 ft. more water than they were designed for, is taken as evidence that levees are a failure! As well say that a bridge is a failure if it breaks under twice the specified test load.

It is of interest to compare the precipitation chart for the March storms of this year (ENG. NEWS, Apr. 10), with the chart for March, 1912, published with Prof. Frankenfield's paper in ENGINEERING NEWS of Apr. 18, 1912. The heavy rains did not fall in the same place. Perhaps the reservoir advocates can design us a reservoir that can be moved about on short notice to where it is most needed!

The faddists are under full steam again, and there seems to be serious danger that they will create confusion in the minds of Congressmen.

I would like to see a National Board of River Control created with General Bixby or Colonel Townsend at its head and with Colonel Goethals on the Board because he is an able man and also to satisfy those who think that no one knows just what to do with the Mississippi River if he has not built the Panama Canal. It would be a misfortune, however, if this Board were entangled by the intricate web that Senator Newlands has succeeded in spinning. It would also be unfortunate if any change should be made in the present policy of providing the Mississippi River Commission with funds to continue the valuable work that they have been accomplishing. The National Board should have had ample time to study the question of river control thoroughly and then recommend to Congress the organization, methods, etc., which it believes should be adopted; but the work of the Mississippi River Commission should not be interrupted meantime.

Reverting to the leveees: From 1897 to 1913, sixteen years, the Upper Yazoo levee district, with an area of about 2 million acres, has had no Mississippi River water in it. From 1903 to 1912, nine years, no levee district on the lower Mississippi had a single break. Yet had the levees not existed, practically the entire lower Mississippi valley would have been inundated several times during that interval.

During an ordinary high-water season when the levees show no weakness, the residents in the valley go about their daily business and a large number of them do not know that the river is above its banks. When, about once in ten years, an unusual flood comes and some of the levees (incomplete because the money has not been provided to complete them) give way, a cry goes up that the levees are a failure. This cry does not proceed, however, from those with the heaviest interests behind the levees. Certain organizations with ends to subserve which the "levees only" system (as they term it) stands in the way of, make as much capital as they can of the few breaks in the levees.

❖

The Troy Dam, across the Hudson River at Troy, N. Y., is about to be put under construction by the Engineer Corps of the United States Army. As has been noted in previous issues of "Engineering News" (Feb. 1, 1912, p. 220; May 18, 1911, p. 604; Jan. 23, 1913, p. 182), this dam has been the subject of considerable controversy between the authorities of the State of New York and of the United States. Briefly stated, some three years ago the State of New York, through its then constituted officials, transferred all rights which it could be supposed to hold in the water powers at the Troy Dam, to the United States, in return for the building of the dam by the federal government. Some two years later another administration in the state attempted to revoke this contract and for a short period the federal authorities ceased work on the project. In February, 1912, Secretary of War Stimson decided that the State of New York had no authority to annul its previous contract and ordered the Corps of Engineers to proceed to the construction of the dam.

The Spring and Summer of 1912 were occupied in the purchase of property rights at the dam site. In September, 1912, bids were opened for the construction of the dam, but they were all rejected on the ground of too high price. Thereupon the Corps of Engineers decided to proceed to the construction of the dam with day labor. This construction is about to commence, as soon as it is possible to get into place the proper constructing equipment. The construction is in the immediate charge of Capt. Roger D. Black, U. S. A., stationed at Albany, and in the general charge of Col. William M. Black, U. S. A., stationed at New York City.

The new Troy Lock and Dam is to be located across the Hudson River at Troy, N. Y., about 1400 ft. above the old timber crib Troy Dam, which has been in service for many years. It is to be a concrete gravity dam of ogee section, with a maximum height above foundation of 35 ft., and an average height of 20 ft., the difference being due to the variations in the river bottom, which is of Hudson River limestone. The dam is zigzag in plan to provide a longer spillway than the width of the river would provide. There is a single-stage lock on the Troy side of the river; comprising an upper chamber 338 ft. long and a lower chamber 182 ft. long, both between hollow quoins, giving an available lock length of from 300 to 310 ft in the upper chamber and about half that length in the lower chamber. The lock is 45 ft. wide and will provide 16 ft. over the miter sills at the lowest low water, which is 4 ft. greater than the greatest depth provided over the sills of the typical locks in the New York State Barge Canal, for which this lock forms an exit into the Hudson River.

On the west side of the river there is to be made provision for future water power, with immediate power provided for the operation of the locks. It is estimated that 4000 hp. can be developed at this site by the new dam in contrast to about 1800 hp., which is developed at the present Troy Dam.

The controversy between the state and the federal government as to the ownership of future power remains in statu quo. State Engineer Bensel recommended in his last report that the Legislature make some arrangement whereby the State would be benefited by this power, and it has been indicated by previous Secretaries of War that the federal government will be willing to make such an arrangement.

❖

A New Type of Rubber Cushion Tire for automobiles, which is claimed to be as elastic and easy riding as the pneumatic tire, has been developed by the Overman Tire Co., 250 West 54th St., New York City. The tire has dovetailed recesses cut into it from each side alternately. These recesses allow the rubber between them to expand laterally when the weight comes upon each section, so that the total range of motion given by the tire approximates that given by a pneumatic tire. The tire is made of a high grade of solid rubber, and is more expensive in first cost than the pneumatic tire. It is guaranteed for a service of 10,000 miles, however, which makes its cost per mile less than ordinary pneumatic tires, while it has the advantage of reliability and freedom from punctures, and it is claimed also that it has a grip on the road surface which makes unnecessary the use of tire chains.

EDITORIALS

A Solution of the Silt-Removal Problem in Harbor Maintenance

Wilmington, Del., as a seaport, had a commerce during the calendar year 1911 amounting to 859,736 tons, valued at $68,647,051.

The amount of money expended on the improvement of the harbor and its connecting channels since 1836, is $1,107,985, of which the sum of $705,363 has been expended since 1896 on the present project for a channel 21 ft. deep. Dredging by ordinary methods has proved a failure so far as maintaining the projected 21-ft. channel depth is concerned, due to the constant and rapid deposition of silt. Practically four times the amount of excavation, originally estimated, has been already removed and, instead of a 21-ft. channel, only an 18-ft. channel has resulted. And, owing to the accumulation of silt, a navigable depth of only 14 ft. has been maintained.

As the problem of preventing the harbor from rapid shoaling by silt deposits is not unique for the case of Wilmington, Major Raymond's article, printed in this issue, will very likely be found of value in solving similar problems elsewhere. That the economical solution of the problem by dredging has been made possible only by the use of a special type of suction dredge, which has not as yet been very extensively employed in the United States, but whose merits for this class of work have long been appreciated in Germany where it has been used for several years, will be of interest to engineers in charge of harbor maintenance work.

The peculiar advantages of the Frühling type of dredge for just this kind of harbor work were set forth at length in our columns more than five years ago by John Reid, Naval Architect, of New York City, and the ability of this type of dredge to cope with the conditions at Wilmington tends to substantiate the statement then made by Mr. Reid that "the Frühling system of suction dredging will revolutionize present practice in submarine excavation in soft materials, such as sand and mud."

❋

Amateur Engineering in the Newspapers

In a recent letter to the editor of New York *Times* a correspondent writes that he has a valuable suggestion to make. He had long observed that asphalt pavements were very satisfactory, indeed they seemed to him to have but one drawback; they were slippery in wet weather. Happy idea! why not prevent them from being slippery. How? Why so easy it is strange no one ever thought of it before. He would put grooves in the surface by rolling the new pavement with a cleated steam-roller! He hoped the city engineering officials would consider this.

It is unfortunate that one so well qualified to suggest improvements in asphalt pavements did not go more into detail as to how a corrugated steam-roller was going to be managed so as to go back and forth over the pavement always in the same grooves. Nor did he explain how his grooved pavement would have any advantages over a stone block pavement in which the joint filling is worn away.

It would be wasted time, probably, to try to explain to this genius that engineers have for years been trying to eliminate the joints in block paving so far as possible, so as to secure a perfectly smooth surface which offers least resistance to traction and has the least wear.

Again in a later issue of the same newspaper is an article headed in large type "To End Flood Perils by Diverting Water," which begins as follows:

> Carroll L. Riker, the civil engineer who proposed last year that the Government guard Atlantic ship routes from ice by building a jetty across the Grand Banks of Newfoundland, announced yesterday that he had devised a plan by which the Mississippi Valley could be protected from floods.

Mr. Riker's "plan," briefly described, is to create a new channel for the surplus flood waters of the Mississippi, extending from Cairo to the Gulf on the west side of the river. The new channel is to be ten miles in width, and Mr. Riker glibly remarks that the land within this channel "has only one or two minor villages upon it and could no doubt be obtained by the Government for less than $5,000,000 under condemnation proceedings."

Considering that these delta lands are sold at $40 to $200 an acre, Mr. Riker's estimate is perhaps a little sanguine. Not more so, however, than his statement that

> The most difficult engineering job of the problem would be the simple task of forcing some steel tubes through the soft alluvial soil under the Red River.
>
> The tunnel under the Red River is really the secret of the whole proposal. You repeat that tunnel under the Arkansas when you get up that high.

To an ordinary engineer, building tunnels under a river to carry the volume of water delivered by a flood channel ten miles wide might seem a bit herculean; but to a transcendental engineer like Mr. Riker it is merely "a simple task."

If Mr. Riker has any claim whatever to the title Civil Engineer, he would do well to consider that article in the code of ethics, in force in some of the national engineering societies which prescribes that new inventions or projects in engineering work should be spread before engineering societies, or in the technical press before publicity is sought in the newspapers. The contrary course may tend to seriously injure the reputation of the profession in the public mind.

❋

Lending City Credit to Aid Railway Projects

We commented recently in these columns on the revival, by a North Carolina railroad promoter, of the old scheme of obtaining local aid from towns along the route of a proposed railway, in the shape of bonuses or subscriptions to stock. There has since come to our notice an appeal for local aid on a larger scale which is

being made to the city of Denver. The Denver, Northwestern & Pacific R.R., partially built by the late D. H. Moffatt, has been reorganized as the Denver & Salt Lake Ry., with Newman Erb as President. The City of Denver is asked to aid in the construction of the tunnel under James Peak on the line of this road, which is necessary to its economical operation. As the present charter of Denver makes no provision for a loan of the city's credit for such a purpose, an amendment of the charter is to be submitted to popular vote on May 20, under which, if the amendment is approved by the voters, the city may legally pledge its credit to aid in the building of the tunnel.

As to what the terms are under which the city is asked to lend its credit to aid this enterprise, we have no information, but it may be safely said that with the present-day need for expenditure for regular municipal purposes, there are very few cities anywhere which can safely undertake to borrow money to aid railway or other corporations outside their own borders.

We referred in our recent note, to the fact that many towns and cities are today paying interest on money borrowed many years ago to aid promoters of railway construction schemes. In not a few instances where such local aid was given by towns and cities, the road was never built.*

There are a number of counties in the South and West, where the people have repudiated payment of interest and principal on bonds issued under such conditions. A recent press dispatch reports the case of Dallas County, Mo., which issued bonds to the amount of $235,000 over forty years ago, in the aid of the projected Fort Dupont & Laclede R.R. The road was never built, and the interest which has accrued on the County bonds then issued makes the total amount outstanding over $2,000,000. Holders of the bonds have been for over thirty years endeavoring to enforce payment of principal and interest through the Federal courts, but the state judges in the local county courts have defied the Federal court orders requiring the assessment of a tax levy upon the county, to make a payment on the bonds. Through their failure to obey the Federal Court's orders, these judges have been held in contempt, and warrants have long been outstanding for their arrest and confinement. The judges, however, so far have successfully eluded the Deputy United States Marshal's attempts to arrest them, and are, of course, supported in their position by the public sentiment of the county. There are other counties, we believe, where for years the judges elected to office have been at once arrested and imprisoned, and have accepted their election with the understanding that this would be the case.

Such conflict between the Federal and the State judiciary comes dangerously near to anarchism. It has been well said that evil begets evil. The voting of local aid to railway companies in the period of active railway promotion, 25 to 50 years ago, more often than not was accompanied by corruption on a huge scale. The interests which sought to obtain a vote of city or town or county, in favor of local aid, more often than not purchased the support of influential men by every possible means, and upon election day, bought votes by the wholesale at so much a head.

It is no wonder that the present generation repudiates its obligation to pay debts incurred under such circumstances, a quarter of a century or more ago.

It will be well for Denver, or any other city or town, which today is asked to lend its credit in the aid of a private enterprise of any sort, outside its own borders, to consider carefully the disastrous results which have in the past almost without exception followed such misuse of public credit.

*"The total county and town aid to railway construction given in the entire country probably amounted to several hundred million dollars." Johnson's "American Railway Transportation."

New Haven Railroad Financiering

That tangled web of corporation finance which has been revealed to the public in the investigation now being conducted by the Interstate Commerce Commission of the New York, New Haven & Hartford R.R. Co.'s affairs will have great influence in alienating the intelligent public opinion whose support the railways so much need at the present time. We have spoken so recently and so emphatically in these columns regarding the injustice of indicting the chief officers of the New Haven company on the charge of criminal responsibility for railway accidents, that we may the more freely express disapproval of the work which has been done by those in control of the New Haven Co. in complicating its finances.

It is not merely the railway travelers and shippers of New England who are criticizing the officers of the New Haven Co.; it is thousands of its stockholders. These stockholders can recall the time, not many years ago, when the stock of the New Haven, and Boston & Maine, and Boston & Albany, and half a dozen other high-class railways of New England was regarded as a gilt-edged investment. Their dividends were considered as certain a reliance for income as the earnings of bank stock or of conservative New England manufacturing corporations.

Since that time a consolidation craze has swept over New England and its entire railroad system has come under the control of the New York, New Haven & Hartford Co. and the New York Central lines. Coincident with this change has come a steady fall in the prices of these gilt-edged stocks and a drop in the dividend rate or its entire disappearance. Stockholders are not satisfied with the explanation that this is all because railway profits have fallen off because of the increase in railway wages and in the prices of railway materials. They know very well that during the past ten years the capitalization of the New Haven has been enormously increased. The burden of proof lies upon the officers and directors who have been responsible for this increase to show that it was wisely and honestly made.

In view of the revelations made before Interstate Commerce Commissioner Prouty last week, we fear some of the New Haven stockholders will conclude that the company made use of the money raised by its increased capital to purchase cats and dogs. They may have been cats and dogs with a fancy pedigree, but there is such a thing as purchasing them at too high a price.

There are many old-fashioned people who still believe that the best way to run a railroad is to stick to the railroad business and who insist that the stockholders and patrons of the New Haven system would have been better off today if its management had been contented to

do this instead of loading itself up with trolley roads and hotel companies and steamboat lines and all sorts of side enterprises. There are those who contend also that the millions which have been poured like water into the work of converting the main line from New York to New Haven to electric operation has been a bad investment for the New Haven stockholders.

All this tangled web of corporation finance may be capable of explanation; but any such maze of financiering is in itself sufficient to arouse the suspicion that the web has been woven to cover and make impossible of detection the looting of the company's treasury. To put it plainly, the New Haven financial tangle is strongly reminiscent of the malodorous financial jugglery by which thousands of investors in New York street-railway lines were fleeced a few years ago.

We know of business men at the head of large corporations who believe that the abuses of the holding-company system are so flagrant that corporations should be forbidden by law from holding other corporation's stocks. There is no doubt that such sweeping legislation would be a hardship in many cases, since it often becomes desirable for perfectly proper purposes that one corporation should own an interest in another. This much may be said and said emphatically, however, that the abuses of the holding-company system and of intercorporate relations have become so serious that any honestly managed corporation should endeavor to reduce its financial relations with other corporations to the lowest possible limit. The aim should be to keep the business of a corporation so simple that its stockholders can have a reasonable understanding of what their property consists. Those who weave such financial webs as now entangle the New Haven's affairs lay themselves open to the suspicion that they have deceived the people whose property they hold in trust.

❖

Grouting Gravel in River Beds

Some of the older readers of ENGINEERING NEWS may recall articles published in this journal in the early '90's by Robert L. Harris, who died in 1896, describing a system of forcing cement grout under pressure into permeable ground, such as sand or gravel, for the purpose of making it watertight or to add to its sustaining power. Mr. Harris, who was a well known engineer of that time, made a number of experiments and we believe took out patents on the system and carried out successfully engineering works on this plan. A somewhat similar process was described about the same time, in various papers, by W. R. Kinipple, an English engineer who built breakwaters and other structures by dumping riprap or artificial blocks into the sea and then filling the interstices with grout.*

This experimenting and early work was done at a time when cement was comparatively an expensive material. With cement at present prices it would be possible to bury a lot of it in permeable ground, according to this method, if the desired results could be thereby secured. It must be said, however, that neither in dam construction nor in foundations has this grouting system ever been adopted to any considerable extent. The reason can be summed up in a few words. It is that the engineer is never quite certain of these results. When a man's reputation is at stake he is not inclined to run risk for the sake of saving a certain amount of money.

This attitude is entirely proper. Even if in nine cases out of ten, pumping grout into a gravel stratum below the foundation course of an important dam would shut off the flow of water beneath it and make it secure, no engineer will wish to take the risk that in the tenth case water may find its way through between the grouted strata and cause a washout which may wreck the structure. Similar conditions obtain in the case of a bridge pier. Every engineer responsible for the safety of a bridge structure would prefer to see the bed rock laid dry under the piers and the concrete and masonry laid on it in the dry rather than build any other type of foundation. Of course it is in many locations not possible to do this; but pile foundations or cylinder piers will be the recourse of the engineer rather than any experiments on forcing cement into the underwater strata, to go he knows not where.

Nevertheless the grouting process has its field of usefulness; and experiments with it continue to be made. A notable recent case was the work on the Hale's Bar lock and dam, near Chattanooga, Tenn., where it was attempted to fill up the cavities in the limestone strata along the line of the dam site across the river by pumping in grout. According to our best information, the experiment was a failure and it was decided to adopt more certain methods of making the foundation watertight.

In our issue of Apr. 3, Mr. D. W. Cole described the use of the grouting system for closing seams in deep strata under the Lahontan Dam in Nevada on the Truckee-Carson project of the United States Reclamation Service. Here a double line of 2⅜-in. holes was drilled through seamy rock to a depth of 30 to 70 ft. below the trench bottom, the holes being spaced 3 ft. apart in each row, and the rows being 2 ft. apart. The holes were first tested with water under a head of 127 ft. and the grout was then forced in under a pressure reaching 100 lb. per sq.in. until the hole was filled. With such careful and thorough work it may be admitted that small likelihood exists that any unfilled crevices could remain between the drill holes through which water in any dangerous amount could ever find its way.

On the other hand when work is done thus thoroughly, the saving by the grouting process is not great. On the Lahontan Dam, the estimate of the saving made was only $3300 compared with the cost of trenching and filling with concrete to the same depth. Many engineers would prefer the trenching method where the difference in cost is so small.

*Some additional examples of the use of this system are as follows: At the International Engineering Congress held in Chicago, in 1893, a paper by E. Neukirch, of Germany, described a method of solidifying submerged sand or gravel by forcing dry cement through a pipe by compressed air, the agitation caused by the air serving to mix the cement with the mass of material. This process was actually used in some sewer construction.

A more general practice is to use liquid cement grout, and a process of this kind used in France for shaft and tunnel work in water-bearing gravel was described in our issue of June 1, 1911. A similar process used for converting sand and loose stone into monolithic masses in English harbor work was described in our issue of Oct. 12, 1893. A recent application of the same process was at the La Salle St. tunnel under the Chicago River ("Engineering News," Aug. 10 and Sept. 21, 1911). The river tunnel is a twin-tube steel shell sunk in a dredged trench, and a cofferdam was built over each end to enable the connections to be made with the land or approach tunnels. To make the coffer-dams water-tight at the bottom and around the curved sides of the tunnel shell, before pumping out the water, loose stone was deposited, in which vertical pipes for grouting were embedded. When the stone had been filled to the desired depth, cement grout was forced in by compressed air. The result proved very satisfactory.

It should be emphasized that the Lahontan work was the grouting of cavities in seamy rock. This is a safer and more certain proposition than pumping grout into sand or gravel.

In a paper published elsewhere in this issue are described some quite elaborate experiments recently carried out for the Louisville & Nashville R.R. to determine the possibilities of applying the grouting system to the formation of pier footings in the gravel bar of a river. The experiments are reported in considerable detail and are well worth putting on record for the benefit of any engineers who may wish to investigate the possibilities of this process. We are of the opinion, however, that those who carefully follow this record of experiments will not be favorably impressed with the process as a method of providing foundations for a permanent structure. Even if it be taken as demonstrated that in the hands of an engineer of sufficient experience and judgment a fairly thorough cementation of the underlying gravel can be secured, there is always a chance that carelessness at some point of the job or the presence of a stratum of pure clay or silt instead of gravel may result in a weak place in the structure which may eventually give serious trouble.

The best and most certain results with the grouting system have been obtained where it was applied to seamy rock or to filling the interstices of clean broken stone previously deposited.

But if it is a question of saving cost in making a deep foundation in water-bearing material, most engineers would prefer to dredge out the material and then mix the concrete in the desired proportions and deposit it through the water with a tremie, rather than take the chances of forcing grout into the strata in place.

LETTERS TO THE EDITOR

Some Results of the Cannon Firing on Buildings in Mexico

Sir—Your readers may be interested to see some of the photographs of buildings in the City of Mexico which were subjected to heavy cannon fire during the recent street fighting in that city. Fig. 1 is a reinforced-concrete apartment hotel on the Paseo de la Reforma, built in 1912. The Madero troops occupied the roof of this building and some of them are seen in the picture guarding the windows on the first floor. The windows on the top floor were broken by bullets and the surface of the concrete wall, which had an excellent smooth finish, was pitted by machine-gun fire, otherwise the building was not injured.

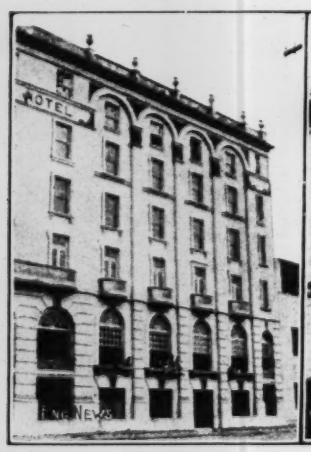
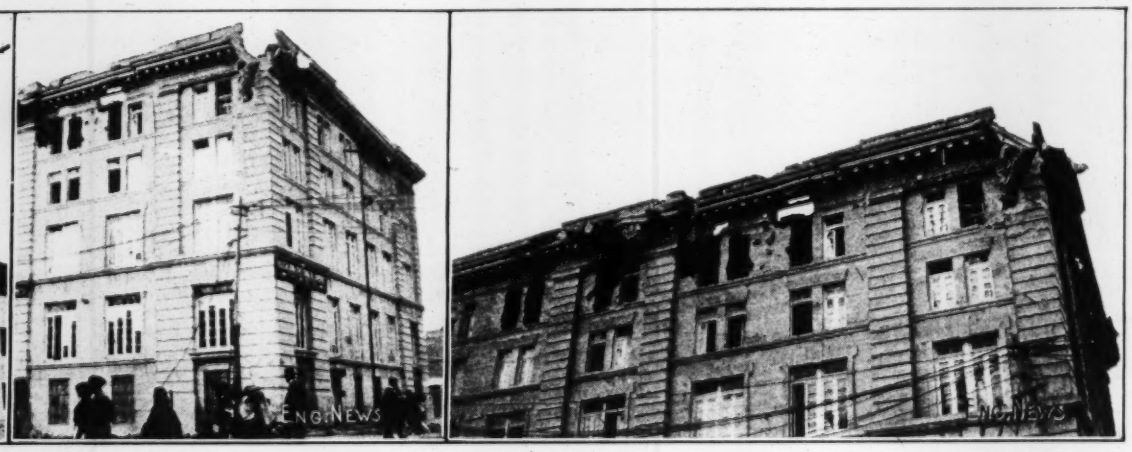


FIG. 1. APARTMENT HOTEL OF REINFORCED CONCRETE



FIGS. 2 AND 3. THE REINFORCED-CONCRETE Y. M. C. A. BUILDING

Figs. 2 and 3 show the results of 10 days' cannonading on the reinforced-concrete Y. M. C. A. building in Balderas street. This building was erected about 1910. It has a metal cornice with a low parapet of hollow tile above. The exterior of the building was badly pitted by the shots, but the structure received comparatively little injury considering the heavy fire to which it was exposed for several days. The building was occupied by the troops of Felix Diaz, and cannon were mounted on the roof, which did effective work. Fig. 4 shows the damage done in a very short time by Diaz' cannon on the rubble masonry walls of Belem prison, and on the wall surrounding the prison yard, which was built of large pieces of soft stone. The Madero cannon, which were located here, were quickly silenced. Fig. 5 shows the field gun which did this effective bombardment on Belem prison. The gun was placed half a block from the prison at the corner of Balderas St. It is fair to say that the gunners who worked this and other Diaz artillery were under direction of a Mexican officer who received his military education in France and they did remarkably accurate shooting. Fig. 6 shows the cannon lined up before the National Palace. The gunners in charge of these pieces stayed in position behind them for five days after the capture of Madero.

R. B.

City of Mexico, March 10, 1913.

The Dayton Flood

Sir—Since returning from Dayton, I have read with interest your accounts of the flood, and they are very accurate. A great deal of thinking is going on as to what caused the flood and how such floods can be prevented.

The daily papers of Mar. 26 and 27 claimed the high water at Dayton was caused by broken reservoirs. It was later found that none of the reservoirs had broken or even overflowed their banks.

FIG. 4. RESULT OF CANNON SHOT ON BELEM PRISON WALLS

FIG. 5. FIELD GUN TRAINED ON BELEM PRISON

The newspapers told of a "wall of water" which was sweeping down the Miami, in spite of the fact that Dayton and Hamilton, where the worst damage occurred, are over a hundred miles by the river from the reservoirs. It is evident that the reservoirs at their remote location and with their low banks could not create flood conditions even should their banks give way.

This then answers one of the schemes presented for the prevention of floods, for if the reservoirs could not hold enough water to create destruction, they could not reserve enough water to prevent it.

Claims have been made that the flood resulted from encroachments on the river channel and not enough clearance under the bridges. Both of these conditions increased the disaster but cannot be accepted as the main cause.

The flood resulted from the excessive rainfall. The average rainfall in this district is some 50 in. per year. The Miami River drains some 2500 square miles and the contour of the land is such that the water flows off rapidly. The rainfall over this whole watershed averaged 7 in. for the two days preceding the flood and in some places as much as 11 in. fell. The ground was saturated at the start so practically all this rain ran off.

Many wild plans are proposed to remedy the trouble. Agitation of remedies will mean votes for Congressmen. One plan now is to dig a new channel through Dayton two miles long, 30 ft. deep, and 800 ft. wide. It is argued as being feasible in that the "dirt excavated can be used to refill the old channel and so replace building sites destroyed." Of course no mention is made of the buildings that would be wrecked or the cost of the undertaking. Some minor changes in the river channel, of course, will be made.

The damage done is indescribable. The one miracle is the relatively small loss of life. The telephone companies did wonderful service in spreading the alarm but the warning to the poorer people came from an unofficial source. The engineer at the Platt Iron Works left word Monday evening to be called in case the river rose so as to throttle the discharge water from his condensers. He was called before midnight and before 4 a.m. it was evident that the river was going over the levees. He accordingly tied down the factory whistle and let it sound till daybreak. This alarm aroused many people who were thus enabled to reach safety. The water overflowed the levees shortly after 7 a.m.

Prevention of a similar catastrophe, should rainfall

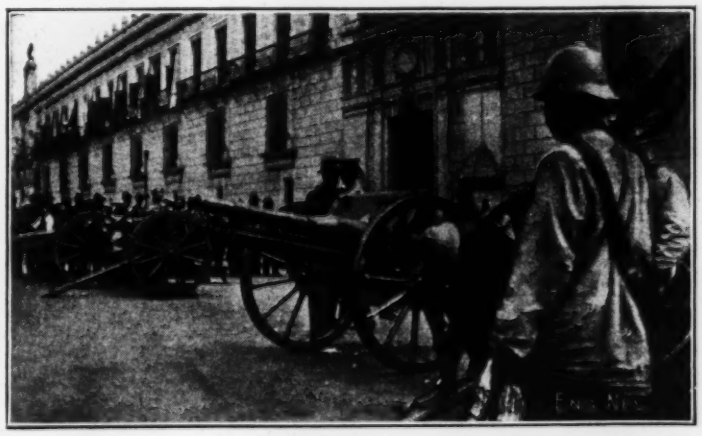


FIG. 6. ARTILLERY IN POSITION IN FRONT OF NATIONAL PALACE

conditions be duplicated, is absolutely impossible on account of expense. However, the levees should be made strong enough for ordinary floods and then trust that this will be the last cloudburst.

H. C. WIGHT.

Commonwealth Bldg., Philadelphia, Penn.
Apr. 26, 1913.

The Bill to License Engineers in New York and the Technical League

Sir—As an old subscriber and one who is interested in the improvement of the status of the civil enginering profession, I wish to defend the bill for the licensing of engineers introduced in the New York legislature, by quoting from your issues of Mar. 27, p. 639, and Apr. 3, p. 680 and 697.

In the first place this bill was introduced by Assemblyman Jesse P. Larrimer, himself an engineer and constructor. Knowing the responsibilities of engineers upon construction work, it is but natural that he should introduce such a measure. The records of collapsing structures that fill your present news columns should be eloquent and convincing proof of the need of such a measure in more states than New York.

The Technical League of Engineers has given this bill the closest of study and it meets with their unqualified approval. The League, it is stated, has a membership of about a thousand engineers in all parts of the country, a large majority being residents of New York. Naturally they see great merit in Mr. Larrimer's bill. They are desirous of seeing proper safeguards placed over public works, for the public benefit, and of having all such civil engineering and surveying work done or supervised by men competent to qualify under the regulations of the State Board of Regents.

Many eminent engineers appeared before the Committee on Public Education, including our worthy State Engineer and Surveyor, Mr. John A. Bensel, advocating the principle of licensing, yet your published articles, above referred to, do not so state nor aim to give this additional truth. Your chief aim appeared to be to belittle the Technical League of Engineers (which you cannot do) and to create false issues to befog the merits of the bill.

Again, is seems strange that you argue "that the proposal to place the whole engineering profession under State control means no benefit to the profession, but a serious injury," when the sentence you quote from the bill says only "——in the designing, construction and engineering inspection of *public works* which require engineering experience," etc., etc., as civil engineer or surveyor.

Again, no greater misstatement of fact can be made than that "the bills which have been introduced and pushed in the New York Legislature appear to be solely due to an organization of which nothing but the name is definitely known, its list of members and its officers being kept a secret." If you refer to the Technical League, it has for some time been incorporated under the New York law. Is that secret? Whoever saw tabulated for the use of unscrupulous critics or foes a list of names of the members of *any* organization? The membership in such a case *must* be confidential, lest the list be used to the possible injury of some member not personally at fault in any detail of his work but whose beliefs were in sympathy with the "under dog."

To show the absurdity of your above quoted statement, you say a little further on, "There are, for example, sound arguments in favor of the proposition that those who engage in the work of land surveying should be examined and licensed. Such a thing is entirely practicable and has in fact been carried out in many cities."

Yet this is the very provision and purpose of the present bill, you so badly misquote and attack, viz.: to make it state-wide. The very bill of which you previously stated "there is no public demand whatever for the passage!" Did that result also come about through the "secret" efforts of that organization known as the Technical League of Engineers?

JOHN C. LOCKE.

1880 West Seventh St., Brooklyn, N. Y.
Apr. 10, 1913.

[We give space to the above letter in accordance with our long established policy of giving fair space to both sides of a disputed question. We forbear comment upon it further than to say that so far from misrepresenting the attitude of the various parties at the Albany hearing, our report specifically said:

> State Engineer Bensel said he was in favor of licensing engineers, but opposed to the present bill ("Eng. News," Apr. 17, p. 789).

We may add further that our correspondent *assumes* that the bill which he so energetically defends is a measure for the best interests of engineers. He has a perfect right to his opinion, but he should remember that many other engineers whose years and experience entitle their opinion to great weight and who are as solicitous for the profession's welfare as he can be are convinced that the proposed measure would be wofully disastrous to the engineering profession, and just as much so to the "under dogs" as to the men of higher rank.—ED.]

Sir—I wish to make a few suggestions regarding the criticisms against the Licensing of Engineers expressed in your valuable journal. The fact that the Bill is promulgated by the Technical League, a secret organization and is not desired by the profession at large, is not only untrue but beside the point. The Technical League is *not* a secret organization and the rank and file of the profession have now come to feel that in a License Bill lies the only hope for the future of the profession.

But this is all beside the point; what difference does it make who fathers the Bill? Why not criticize it upon its merits and upon that only?

Again: The object of the Bill is to protect the *Public*, its benefit to the profession is secondary and is a point not considered from a legislative standpoint.

In your editorial of April 3, it is stated that examination of the plans and inspection of the construction of an engineering work would be a greater safeguard to the public than would be the examination of the engineer thereof.

Assume that they were of equal value as safeguards, would it not be better to do both? Is there any objection to having two or even more safety devices on an elevator car? Would not your sense of safety grow stronger in proportion to the number of such devices on the car in which you rode?

But are they of equal value? The examination of plans and specifications also is practiced to a greater or less degree almost universally and yet enormous errors creep through. It is a simple matter to criticise what appears on the plans and in the specifications, but it is quite a different matter to discover such vital points that the engineer, if he be incompetent, fails to consider and here is where most of the trouble lies.

It is more important that a competent engineer lay out the work than that it be checked—and by whom? *Another unlicensed engineer?* The same applies to the inspection of the construction of the job.

MONTAGUE PALMER.
1032 Jackson Ave., New York City.
Apr. 14, 1913.

Sir—I should like to sound a warning note to the profession in respect to the general subject of licensing engineers, and more particularly in respect to the licensing bill introduced in the Assembly of the State of New York and at this writing under consideration by the Committee on Education. The writer appeared before the Committtee on Apr. 1 in opposition to this bill, as one of a Committee of the American Institute of Consulting Engineers and in so doing became acquainted with its objects.

An abstract of this bill was made in your issue of Mar. 27, 1913, which will serve to enlighten those not familiar with it. As is perhaps generally known, this measure or one very similar to it has been actively indorsed, if not presented, by what is known as the Technical League of America, an organization whose membership is presumably secret, but which is understood to contain principally employees of the various engineering bureaus of the City of New York.

In the hearings before the committee, those in favor of the bill were ably represented by competent and experienced counsel, so that it is fair to presume that an energetic and faithful effort is being made by a branch of engineering to secure the passage of this bill, but just for what specific purpose I am unable to suggest. Perhaps it emanates in the thought that the licensing of so called civil engineers will restrict the number engaged in practice in the State of New York, and thereby raise the salaries and better the conditions of those who are now urging the passage of the act.

It seems to the writer that this branch of engineering, which we may safely presume contains a majority of the younger element, is pursuing a false hope. Does not their endeavor tend to lower the dignity and worth of the profession in the "public eye"? It must be remembered in this connection that the general public, and I mean by this the people who have not been brought into business contact with engineers, do not know the difference between an engineer and a rodman or draftsman. In the public mind, anyone is an engineer nowadays who can draw a pen along a straight-edge, do plane surveying, inspect pavements, or tap rivets.

Now, if the bill before the New York Assembly becomes a law, it will permit any person with a slight acquaintance with construction work and preliminary ideas of engineering to obtain a license as a "civil engineer." From the public standpoint, therefore, the young student of a correspondence school or a rodman of three years' experience will become under a state indorsement the equal of the chief engineer of a large enterprise. The result will be that the public will have no means of knowing or judging between the competent engineer who is able to design and construct large works and his youngest and lowest-grade employee.

It appears to me, therefore, that the Technical League of America is acting most unwisely in their efforts to regulate the civil engineering profession. Instead of depending upon individual effort to attain responsible positions through their superior officers and confining their efforts to the discussion and solution of the municipal engineering problems that they are daily undertaking, they are endeavoring to bring about their advancement by legislation.

In the opinion of the writer, if they succeed in passing their license bill, they cannot hope to attain the ends that they seek. Their promotion and their compensation will still depend upon individual merit, experience and ability to hustle, and this evidence will always be interpreted and reviewed by an older and experienced engineer who has risen by such means from their own ranks. The writer speaks from a broad experience in practical work covering many parts of this and other countries in which he has worked as an assistant and as a chief. His experience is now expressed with the most kindly and paternal feeling for the young graduate as well as for the apprentice and others who are not fortunate enough to pursue their preliminary studies in an engineering school. He desires now to remind the younger and rising generation of engineers that there is always "plenty of room at the top" which is gained only by hard work, application to the fundamentals of civil engineering, and the acquired aptitude to handle men, and to warn them that these qualities cannot be obtained by legislation.

Many able and interesting discussions have appeared in your columns on this subject, and reference is frequently made to the fact that other professions are licensed, namely, medicine and law. There is no parallel between these professions and that of civil engineering because in the first place medicine, law and kindred professions are generally, if not always, practiced in one locality. Mistakes made in law and medicine by their practitioners are buried in the court and the grave, and the public never know of them. On the other hand, the engineering profession is country wide and world wide. It is not bounded by a given locality. It is interstate and not intrastate. The mistakes of an engineer are plainly seen, are reported upon by the press, and the public know about them. Engineers, therefore, perform their work knowing that mistakes and even errors of judgment cannot be hidden, and knowing their plans and acts are subject to public view and criticism.

If there is no parallel between the professions, the licensing of civil engineers can only mean one thing and that is lowering the already questionable dignity of the profession. Plumbers, chauffeurs, engineers of steam plants and boilers are now licensed by the state, and if the civil engineering profession is licensed, it tends to put it on the same plane.

The Larrimer bill now before the New York Assembly is of vital interest to engineers outside of New York State. It is with this particular purpose in mind that I am taking up your space, knowing that in no better manner can the engineeers of the United States be brought to a realization of these facts.

The Larrimer bill provides for licensing the civil engineer of "public works." Railroads, private water, gas, electric, hydraulic, irrigating and other plants are quasi-public works. They are recognized as public utilities. If the court should interpret these works built by private capital, together with the steam and electric railroads of the country as public works, the bill means that no engineer from outside of New York State can be employed upon them without obtaining a license from the State of New York. It is true that provision is made in the bill allowing engineers from another state to practice in the State of New York, provided such state licenses engineers and that its requirements for license are not less than the requirements for obtaining a license in New York State. Only a few states at present license engineers, and these states generally license a particular branch of civil engineering such as surveying, or irrigation works. Again the Chief Engineer of the Panama Canal (were he not a military engineer who is exempt from this act) could not practice in the State of New York without a license, nor could an employee of the Panama Canal, or of any of our colonies obtain employment or practice civil engineering in the State of New York, before obtaining a New York license.

I point to only a few glaring objections to this specific bill, with the single hope that all members of the profession both young and old may see the objections to a bill respecting the general subject of licensing engineers and to show why a statute for such purpose should be drawn with the greatest care through the aid of the older engineers, and not by the employees of a City Bureau.

The writer recognizes that perhaps the time has come when public opinion demands the licensing of civil engineers, especially in this state. He does not for a minute admit that the public who employ civil engineers or who come in contact with them so demand, but he does recognize that public opinion probably does demand that civil engineers be licensed, as evidenced by several state legislatures in their efforts to legislate for and against everything and everybody, and by the dissatisfied who appeal to the legislatures. Such being the case, it is quite evident that the engineering profession must awake to the demand of these legislatures and forestall adverse and improper legislation by suggesting legislation of its own.

The engineering profession is represented by the four large national societies, the Civil, the Mechanical, the Mining and the Electrical, in which are incorporated the best minds and characters in the profession admitted only under restricting qualifications. There is also the American Institute of Consulting Engineers, containing among its members the Past-Presidents of several of these societies as well as others of influence and experience in the four branches of engineering. It seems to the writer that these five societies could, through a joint committee, prepare a model bill for the licensing of civil engineers. After the adoption or approval of such a bill by the Societies, it should be placed in the hands of a committee in each state in the Union with instructions to present such a bill to their respective State Legislatures and urge its passage. This procedure would result in a bill molded to best suit the requirements of the many branches of civil engineering. (When the writer here speaks of civil engineers he refers to all engineers except military engineers.) This procedure would also result in a uniform law and stop the possibilities of a different law for each state. The licensing of civil engineers, because of their interstate duties and practice, should be done by a federal law if such procedure were possible.

There is today probably a need for the licensing of land surveyors and irrigation engineers who are employed usually by farmers whose experience does not fit them to properly judge of the qualifications of a surveyor or an irrigating engineer. The stamp of state approval upon these men would be a great advantage to such employers. The writer here only admits the public necessity of licensing only such branches of civil engineering work. He believes and advances the suggestion to the profession that broad civil engineering should be licensed only upon the same terms and qualifications as exist in the National Engineering Societies. He suggests that the licenses should be in two or three grades.

The first grade to be a probationary license to cover the first year's practice in the profession after graduation or apprenticeship. The second grade to cover a junior license with qualifications akin to Associate Members of the American Society of Civil Engineers. The third grade Senior and full license to be granted upon qualifications equal to full membership in the American Society of Civil Engineers.

In the case of two grades, the probationary period might be made longer and the full license given after such period. The writer believes that written examinations for a license are not advisable because of the fact that the younger mind, not burdened with the general responsibilities incident to the profession, can probably pass a better examination than the older and experienced engineer, or again the man with the photographic mind but without practical aptitude may pass such an examination more easily than the older members of the profession.

This may bring before the profession the suggestion that it would perhaps be wiser to have the qualifications for licensing merely that the applicant must be a corporate member of one of the four national engineering societies. This is already done in the province of Quebec and while it may not appeal to the public at large, as tending toward discrimination, nevertheless, it has the distinct advantage of throwing the responsibility of licensing an engineer as competent entirely upon the profession where it should belong.

Finally, I would make a direct appeal to those engineers who have hoped to better their position by legislation to heed the old railroad sign, STOP, LOOK AND LISTEN and depend upon their profession to assist them instead of state legislation.

The writer is in the most hearty sympathy with those civil engineers who feel that the engineering societies, and especially the American Society of Civil Engineers has done little or nothing to advance their interests. The writer is well aware that the American Society of Civil Engineers needs an awakening in its management and in the conduct of its affairs so far as they relate to the assistance of the profession at large and its individual membership.

It is truthfully said that the only benefits of membership in the American Society of Civil Engineers is the receipt of a few publications, the value of which is yearly deteriorating, and the honor connected with membership.

This is the oldest and richest society of all, and that it should do something to assist and benefit its entire mem-

bership is evident to many of its members. It could work in no better cause than in the accomplishment of beneficial legislation in behalf of the engineering profession.

As evidence of its supineness in the particular instance above suggested, it is enough to say that the Society was not even represented at any of the hearings held in Albany on the above bill. The writer is of the opinion that if the American Society of Civil Engineers will interest itself in assisting its members, not only in legislation in the various states but also in the general problem of maintaining ethical standards and a code of fees and compensation, bills such as the Larrimer bill in Albany would never be presented. We have passed the age of individual effectiveness and we are in an age where organized efforts of an association can alone accomplish results.

F. A. Molitor.

35 Nassau St., New York City.
Apr. 10, 1912.

Sir—There has been much discussion of late on licensing engineers and I would also like to express my ideas upon the subject. The agitation for licensing engineers has been started and backed by an organization composed entirely of engineers under the civil service. These men, not being satisfied with their "hard labor" of six hours a day at fat salaries, are trying to get up a sort of barrier in the form of this license system so that they will have as few competitors as possible in the future. They claim that they want to help the engineers and bring them onto the same level as the doctor or lawyer; but can any of these men say that the medical, dental or legal profession is not overcrowded? It is stated on good authority that the average income of a lawyer is $600 per annum.

If one of the men backing this bill had a sudden toothache or headache he would go to the nearest dentist or doctor, not waiting to find out his reputation; but if that same man were about to build a bridge or a steel-frame building, he would stop long enough to find out, either through recommendation or reputation, the kind of engineer this or that man is before he would entrust to him the design of a structure costing hundreds of thousands of dollars. The engineer who got that contract would get it not on account of his license but on account of his experience and reputation.

The license system does not fit the engineering profession for another reason; and that is because 90% of the engineers are hired and not only hired by the week or month or year, but there are reputable civil engineers who hire men by the hour. The profession will not be helped a bit by a license, it will only add an extra burden of taxation on a man who is trying to earn his living. In the design and building of large engineering structures, especially in New York City, the engineers who are depended upon are usually men of long experience and a license is not needed to protect the public.

Morris Whinston.

Brooklyn, N. Y., Apr. 30, 1913.

Sir—Please allow me to express my opinion in regard to the advisability of licensing civil engineers.

My understanding is that the object of state licensing is to protect the people from inferior engineering work by allowing only licensed engineers to practice independently or in an advisory capacity.

To secure a license a man must graduate from college and work under some licensed engineer for two or three years. He will then have the idea that it is below his dignity to be a hireling and will open an office as a consulting or contracting engineer. But will he be any more qualified just because he holds a state license?

At present, a man continues to do good work and employs conservative methods while working under the supervision of a competent engineer; at the same time he is better fitting himself for complete responsibility and is not bringing the chances of an inexperience often dangerous to life and property.

I think licensing engineers would only increase this danger of lack of experience and lower the standard of the engineering profession instead of raising it as is the hope of the license advocates.

The practice of licensing doctors of medicine is often mentioned. They spend the same time to secure a license as will be required of the engineer. But is every licensed doctor fully competent to practice? Should not many still be under the supervision of older heads?

Are all lawyers competent to decide questions of note just because they have been admitted to the bar of the state and hold a license?

Bruce L. Cushing.

Kenmore, N. Y., Apr. 26, 1913.

Sir—The discussion, both editorially and by communications in the technical press, relating to legislation intended to regulate the practice of engineering seems to be largely based upon the assumption that the object of such legislation is mainly sordid, intended to protect the engineer from improper competition, and the public from imposition. Perhaps this trend of the discussion is due to the fact that most of the legislation that has been proposed or enacted in this and other states seems to be predicated upon such motives.

In so far as this is true, opposition to such legislation is warranted by engineers who have at heart the best interests of what we like to call our "profession." We cannot afford to ask or accept legislation that savors of what is usually associated with trade-union ideas or methods.

Furthermore, we do not need legislation of this character. The number of engineering pretenders and quacks is not large enough to seriously affect the business of the legitimate engineer. Nor does the actual loss caused to the public at large through the employment of quacks justify legislation of this kind. The fact is, that the greater part of such loss is due to the incompetence of those whom most of the proposed laws would "license" as engineers.

The fact that the measures so far proposed are unsatisfactory does not prove, however, that proper legislation for the recognition and regulation of the practice of engineering is not needed and would not result in great benefit to the profession and to the public. But to be acceptable to the better element in the profession it must be cast upon a high plane, free from sordid or mercenary motives, and have as its main object the elevation and honor of the profession, and its highest usefulness to the public. Its leading motives should be:

the legal recognition of Engineering as a profession, the establishment and maintenance of high professional standards, provision for the control and regulation of professional practice in accordance with the best moral and ethical ideals, and the clear definition and establishment of the relations of engineers to each other and to the public. These objects cannot, it is true, be attained by legislative enactment; they can only be brought about by the efforts of the profession itself. But the law may confer the necessary authority and provide the machinery that will enable the profession effectually to work toward these ends.

The legislation necessary for this purpose would be brief and simple. It should be confined to the creation of a body or board, composed of members of the profession, and the clothing of this board with power to devise, ordain and enforce a system of internal government and control by and for the profession; together with the necessary details for the appointment, organization and operation of the board. The members of the board, while nominally appointed by the Governor, would be nominated by the profession itself through suitable methods and machinery. It would thus be a representative body actually selected and controlled by the profession.

Subject to the constitution and laws of the State, this representative board would prescribe the terms of admission to practice, enact rules and regulations controlling professional practice and conduct, and define the relations of practicing engineers to each other and to the public. It would prescribe and enforce proper penalties for professional misconduct, and initiate and promote the public trial and punishment of professional offenders against the laws or good morals. It would be the recognized official head of the profession in its dealings with the State and the Public, thus establishing a responsible relation between them that is not possible under present conditions.

Since the members of this board would be selected by, and amenable to the profession itself, and would undoubtedly be men of the highest personal and professional character, chosen with special reference to the duties that would devolve upon them, such a board could be confidently depended upon to organize and administer the affairs of the profession along broad, wise and prudent lines, and to adapt its action to the conditions that might arise from time to time.

This would be difficult if not impossible if the law itself undertook, as most of those proposed do, to establish rigid rules of admission, practice and conduct. It would be particularly difficult if the administration of the law were placed in the hands of a body of men who were not engineers, and therefore incapable of judging what is best for the interests of the profession. As well might the State enact a law placing the control of the medical profession in the hands of a body of lawyers.

Time and space does not permit more than this brief outline of the writer's idea of a scheme for the public recognition, organization and administration of engineering as a *bona fide* profession. He has devoted a good deal of thought to the subject and believes that it would be found workable, adequate, and highly beneficial to the profession and, incidentally, to the public. Of course, its details would have to be worked out with great deliberation and care. We can well afford to take the necessary time to do this. The thing of most immediate importance is to oppose and defeat any attempt at hasty and ill-considered legislation that would, almost surely, be an obstacle in the way of real progress.

S. WHINERY.

95 Liberty St., New York City, Apr. 14, 1913.

The Organization and Functions of a City Planning Commission*

BY WILLIAM A. MAGEE†

Perhaps the chief handicap to a city planning commission in its early days is its undeveloped relation to other forces engaged in the management of the public business. Besides the city officials (with their powers well defined by statute and ordinance), there are the public-service corporations, solidly intrenched behind their legal rights; and also those important adjuncts to civic advance, the many organizations composed of public-spirited citizens devoted to particular reforms and improvements.

The location and design of public works are initiated by the executive department but are subject to the veto of the legislative branch of the city government. But the responsibility for their economic and efficient coördination is not assumed by either department, except in a nominal sense, although abstractly speaking it undoubtedly rests upon both.

Difficult aspects of the problem present themselves in the consideration of the relations of a city-planning commission with the public-service corporations. The passenger railways must be extended and the service improved; rapid transit introduced, the facilities for freight transportation increased, and the cost of the same reduced by the competition that will result from the extension of additional trunk lines to the city. The terminals of all kinds of transportation agencies, whether by rail or by water, must be enlarged and bettered. If these developments are not in harmony with all other physical reforms the city plan will be considerably marred. The corporations, however, are engaged in business for profit and most other considerations are subordinated thereto in the minds of their managers. But they can be induced to submit to this conception of local government embraced in the ideals of city planning.

Turning now to such subjects as playgrounds and recreation centers, bath houses, libraries, industrial and model dwelling sites and buildings and city ornamentation. Whatever progress any locality has made in this field is due to that new class of social forces which embraces what we call civic improvement associations. These pioneers are rapidly leading the way to a vast extension of municipal policy. In the spirit of public philanthropy or other sentiment they are able to construct and even maintain useful and ornamental public works.

The city planner is embarrassed also by a territorial division of powers. Besides the sovereign state there are counties, cities, boroughs, villages, towns and townships. The entire area both within and without the corporate limits must be planned as a whole regardless of the number of governmental units now contained within it. Sooner or later, either through annexation and consolidation or through the medium of a metropolitan district, there will be essentially a unified government. In the meantime thoroughfares must be connected, transportation extended and improved, wasteful duplications in water-supply and sewage discharge reduced. All this is for the alleviation of present conditions and to avoid as far as possible the expense of correction when the day of the single government arrives.

The central idea of city planning must be comprehensiveness of design and coördination in execution. If this is lost sight of, the city planning commission and its purpose are in danger. In its early days let it not specialize, except where it must do so; let it not originate where a beginning has been made by some other body, official or unofficial; let it not investigate so much as stimulate others to investigate; and let it not criticize so much as sympathize.

The commission must have the respect and become essentially a part of the bureaucracy and therefore should receive its appointment from the executive. Since it must have the respect of the public-service corporations, of the voluntary societies and of the authorities of neighboring precincts, it should receive its powers from the legislature. Public

*Abstract of a paper read at the City Planning Conference, at Chicago, May 5-7.

†Mayor, Pittsburgh, Penn.

opinion must be moved to cause the enactment of laws, therefore the membership should be composed of citizens of influence. The number of commissioners and the subordinate force employed need not be large. Although the commission in the main will be composed of laymen, a member trained in civil engineering and one in the law would be of very great value.

After the organization of a city planning commission the first step should be to obtain the aid of a professional adviser. Then survey the whole situation and catalog all the elements involved; the public officials, the corporate officials, the civic societies, the municipal finances, and the required legal powers. After this survey is completed certain forces must be set in motion to lay the ground for the exercise of the functions of the commission on a broad scale. The first aid to the commission will be the public and personal interest aroused in its favor. Therefore, it would be advisable to carry on a well organized campaign of publicity.

Unless the economics of city planning are well developed in its early stages the plans will come to nothing, and therefore as rapidly as possible the enactment of laws should be procured containing the principle of local assessment, public ownership, and the use of the municipal credit in the construction of public works and self-supporting public utilities; and lastly, at the proper stage of development, the commission must obtain the veto power over all plans and designs.

The planning commission will have difficulty is establishing relations with the suburban officers, who are suspicious of annexation and possess inferior financial resources. The solution of this situation seems to lie in the metropolitan district, although it is not an easy accomplishment. In the meantime, representation in the membership of the commission may to a considerable extent open the door to co-operation.

Lighting the Operating Tunnels and Machine Rooms of the Panama Canal Locks

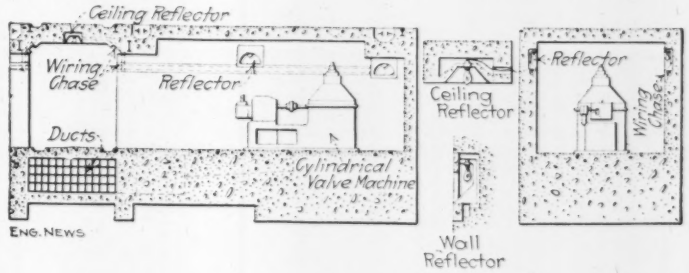
In the *Canal Record* of Feb. 26, 1913, is outlined the progress of work in the design of equipment for lighting the operating tunnels and machine rooms in the canal locks. Recent experiments at the Pedro Miguel locks are reported to show the superiority of the arrangements adopted. Five points were studied in particular: (1) The feasibility of concrete reflectors; (2) the general arrangement of lamps and reflectors for the sort of illumination needed in the inspection and cleaning of machinery; (3) advantage of tungsten-filament lamps; (4) the advantage of whitewashed walls; (5) general character of illumination.

When concrete reflectors were first proposed it was urged that the steel reflectors, covered with vitreous enamel,, could be secured in the United States and would be better. Bids were received on such equipment, but the proposals were unsatisfactory (1) as to price and (2) as to the arrangement of lamps in the shades, so that the concrete reflectors were reverted to.

Difficulty in the tunnel lighting was occasioned by a low head room of 7 ft. Lamps have been placed on 15-ft. centers along the longitudinal axis with alternate lamps on different circuits for economy in operating service. The reflector is simple, consisting of inclined surfaces at the four sides to throw the light flux in proper directions. They are fastened into recesses in the ceiling, as shown in the accompanying figure. About 2100 of these are required.

The machine rooms are individual chambers opening into the operating tunnel. Each houses special remote-controlled motor-operated trains of gears, etc, and the lamps could not be placed at the most desirable points in the ceiling on account of the large covers and manholes which permit hurried access for cranes through the decking. Side-wall illumination was necessary and every effort was made to shade the eyes of the workmen from direct rays. A concrete reflector somewhat similar to the ceiling type is grouted into the wall recess. The front shade, however, has a semi-circular opening at the bottom, which permits the reflection of flux outward, but sufficiently shades the direct vision of the lamp.

On trial it was found that the tungsten-lamp illumination with expenditure of 100 watts power per room



ARRANGEMENT OF TUNNEL AND MACHINE-ROOM LAMPS, PANAMA CANAL LOCKS

was superior to carbon-filament illumination with 220 watts.

By whitewashing the walls of sections of the tunnel and of the machine rooms it was found that diffusion of light was improved and sharp shadows were eliminated. All of the reflectors are now whitewashed but it is expected that this will be changed to a more durable white enamel later.

A Coöperative Forest Demonstration and Experiment Farm is to be operated jointly by the New York State College of Forestry and the Agricultural Department of the New York Central R.R. The experiment will be carried on at the New York Central Experimental Farm No. 2, which is located along the right-of-way of the railroad at North Chittenango, N. Y. The work will begin in the spring of 1913, by the planting of some 15 acres of lowland to white ash, tulip or white wood, Norway spruce, bald cypress, American tamarack and other varieties of trees. Some of the varieties were chosen for general experimental purposes. In a bulletin issued by the College of Forestry, which it should be understood is connected with Syracuse University, attention is called to the fact that European railways are now depending largely upon softwoods or conifers for ties. These softwoods grow rapidly and the ties are treated with preservatives before being used. It is thought that the treated softwood ties rapidly grown as outlined may be cheaper in the long run than hardwood ties, even though it is necessary to use tie plates and screw spikes with the softer wood.

Capitalization of Franchises seems to be permitted in a recent decision of the Public Service Commission of Maryland. The case is that of the Consolidated Gas, Electric Light & Power Co., of Baltimore, requiring it to put into effect a net rate for gas of 80c. per 1000 cu.ft. and a primary rate for electric energy of 8.5c. per kw.-hr. with a minimum charge of $1 per month. In fixing these rates the Commission did not accept the valuation of the company's property by the company's experts (Ford, Bacon & Davis, of New York), $27,485,102, nor the valuation made by the commission's expert (Prof. E. W. Bemis), $15,512,610. A deduction of $5,133,576 was made from the company's figures, and the Bemis figure of $2,016,096 for depreciation was allowed, making the final accepted valuation $20,335,430. Additions of $1,081,984 were allowed to bring the valuation to June 30 last, and $5,000,000 for "easements," making the grand total $26,417,414. Against this is outstanding approximately $44,000,000 in securities. This figure was allowed for "easement" since the company was taxed that amount for the same, and the Commission ruled that it had to value them at such a figure. The Commission recommended that the company adopt a sliding scale for the future adjustment of rates.

Government Aid in Land Drainage*

By Arthur E. Morgan†

In considering whether the federal government should assist in reclaiming swamp and overflowed lands, it is difficult to arrive at a sound conclusion by discussing the subject in the abstract. We can clarify the situation by determining how this policy will work out in a typical case. The St. Francis basin, in Missouri and Arkansas, has frequently been cited as an example of the need for government assistance. Let us consider the matter with reference to this territory.

The St. Francis basin covers about 2,500,000 acres in southeastern Missouri and northeastern Arkansas. Some of the most fertile and highest-priced lands are located here, and there are several hundred thousand acres which now produce crops and which have a market value ranging from $75 to $200 an acre. The remainder is mostly covered with hardwood timber, the timber alone having a market value of from $10 to $40 an acre, depending upon the extent to which the land has been cut over. The greater part of the land on which crops can be raised without further drainage is now in cultivation, and the development of the remainder must wait for the completion of extensive drainage systems.

If the federal government is to pay for the construction of these drainage systems, several serious problems are to be considered. First, there is the question of ownership. Wealthy companies own tracts of approximately 100,000 acres each and probably 75% of the lands now needing reclamation are held in large tracts varying from a few thousand to 100,000 acres. If the lands are to remain in the same ownership, it is doubtful whether Congress will authorize spending millions of dollars in reclamation work, the principal result of which will be to increase the profits of these large owners.

On the other hand, it is doubtful whether these landowners will be willing to relinquish ownership of their lands for the sake of having them drained by the Government. In the St. Francis valley the complete reclamation of all of the swamp lands will cost (on an average) somewhat less than $10 an acre, exclusive of the cost of the Mississippi River levees. Most of the lands which are held in large tracts were purchased by the present owners at from $1 to $5 an acre. After thorough reclamation, and before being put into cultivation, they have a market value of $20 to $50 an acre, with the purchaser still to pay the cost of drainage, which (as a rule) is left as a tax or mortgage on the land. Under these conditions there is a clear profit of $15 to $40 an acre to the owners.

ARGUMENTS AGAINST DRAINAGE WORK BY THE GOVERNMENT

This brings us to the question whether it is feasible for the U. S. Government to undertake this work, taxing the cost against the lands which will be benefited. The first difficulty is that the U. S. Government has no authority to take such action, this power being delegated entirely to the States. This difficulty can be obviated, in theory at least, by coöperation between the federal and state governments.

The question next arises as to who shall decide whether certain lands shall be reclaimed. Under practically all State drainage laws it is left to the landowner to determine whether he considers drainage feasible under the existing physical and economic conditions. Practically all drainage projects are initiated upon petition of landowners. If the Government is to pay the cost in the first instance and to collect it later from landowners, we must decide whether drainage projects are to be undertaken at the request of landowners, or when some Government official decides that it is time to drain the land and to assess the cost against the owners.

In the St. Francis basin, practically all the territory in Missouri and a large part of that in Arkansas, has already been organized into drainage districts, and contracts for the construction of reclamation works have been let. What is to become of these existing organizations should the U. S. Government undertake the reclamation?

Taking the country as a whole, the drainage of swamp lands is keeping pace with the actual demand for these lands when drained at the prices which are charged for them by the owners. If the Government were to undertake the reclamation of those tracts where reclamation by state agencies has not been commenced, it will be found that the Government will be left with many of the poorest and least profitable projects. For instance, at the extreme lower end of the St. Francis basin there is a territory which cannot profitably be reclaimed until the market value of land is much greater than it is today. The same is true along the lower Red River in Louisiana, and along the outlet of many of the smaller streams which empty into the Mississippi River. In some other parts of the country, as in parts of northern Minnesota, the cost of drainage is small, but the soil when drained is almost worthless.

It has been stated that the U. S. Government must undertake the drainage of the St. Francis basin because it is an interstate problem and cannot be handled otherwise. The best answer to this is an examination of the conditions as they exist. The eastern part of the basin is in the watershed of Little River, which covers somewhat more than a million acres. All of this territory in Missouri is now organized into drainage districts and the reclamation has been completed or contracts for its construction have been let. In Arkansas, likewise, nearly all of the Little River watershed is organized into drainage districts or is in process of organization. The plans for the improvements in Missouri and Arkansas are worked out in such a manner that they will coördinate without conflict of interests. Of the lands overflowed by the St. Francis River itself, almost the entire area has been organized into drainage districts, and contracts for the greater part of the work have been let. Of the land along the state line, concerning which there might be interstate problems, over half is owned by the American Sugar Refining Co. (through the Great Western Land Co.), and most of the remainder is owned in fairly large tracts. There is little if any conflict between the projects on the two sides of the line.

It may be noted that this tendency toward coöperation in the case of land lying along state borders is general. Where the overflowed lands of Texas and Arkansas meet along the Red River there has been complete coöperation between the interests of the two states. The district on the Arkansas side is paying about half the cost of the improvement in Texas, that being an approximately equitable apportionment of the expense.

If it should be held that it is the policy of the U. S. Government to promote drainage projects where small ownerships predominate, it will be found that this leads to taking part in inumerable small drainage projects in all parts of the country.

THE PROPER FIELD FOR GOVERNMENT ASSISTANCE

There is a large and very profitable field, however, in which the U. S. Government can coöperate to the very great benefit of the landowners, and at comparatively small expense to the nation. A critical examination of drainage developments which have been carried leads to the conclusion that a vast amount of money is being wasted because the engineering principles have been very imperfectly developed. There are two or three departments of the U. S. Government which could be engaged very profitably in working out by experiment the hydraulic principles upon which our reclamation plans must rest.

Up to the present, these departments have limited their efforts largely to promoting particular drainage projects, and the attention of some branches of the Government service has been directed largely to complying with requests of Congressmen for assistance in their districts. If half of the money spent in this manner were well spent in working out experimentally the principles of drainage engineering, and in securing engineering data (such as the run-off of drainage areas, the capacities of channels, and economic types of construction) the information secured would enable reclamation works to be planned with much greater efficiency.

Moreover, it seems possible for the U. S. Government to be of great financial asistance to drainage development, without great cost. As drainage districts are usually financed, one of the greatest burdens to the landowner lies in the tax due to interest charges on bond issues. Drainage bonds usually bear interest at 6%. If such bonds were guaranteed by the Government, the rate of interest would be reduced to 3% or less, and the landowner would thereby be relieved of about a fourth of the total cost of the improvement.

If such a plan were adopted, it would be necessary for Government engineers to pass upon and approve the plans of any district desiring aid in this manner. And as it is frequently impracticable to plan the drainage of isolated tracts ie would be desirable to make complete surveys of large areas, the greater part of which requires reclamation. It would probably be desirable also for arrangements to be made with state governments, whereby in return for guaranteeing the interest on reclamation bonds, the U. S. Gov-

*Abstract of a paper read before the National Drainage Congress, at St. Louis, Mo., April 10, 12.

†Morgan Engineering Co., Memphis, Tenn.

ernment should take a first lien on the lands to be reclaimed. By this method of coöperation, the U. S. Government would be enabled to give very material assistance, which would in fact amount to bearing one-fourth of the total expense of reclamation, as it is at present carried on, and this could be done with reference to drainage improvements in all parts of the United States with absolute impartiality, and the cost to the United States Government would be nothing beyond the cost of administering the service. Even in this respect the service could be made self-supporting. Such a plan would be a practicable application of a system of rural credits.

Not the least benefit of such coöperation would lie in the examination of drainage plans. While the Government engineer cannot have the same intimate knowledge of local conditions and factors entering into the preparation of plans as has the efficient local engineer, yet in passing on such plans, engineering errors can to a very considerable extent be eliminated. There is probably no field of construction in the United States where so large a part of the investment is usually lost through faulty engineering, as in the construction of drainage improvements. The engineering supervision here outlined would eliminate a large part of that loss.

If any community can have its land drained without cost, by bringing sufficient influence to bear on the Government, the demand for assistance will bear practically no relation to the merit of the situation. On the other hand, if the landowner must pay the bill, and if the assistance of the Government lies simply in reducing the rate of interest on a loan by guaranteeing the bonds, the reclamation of swamp lands will be held to a business basis.

❖ ❖

Tests of Grouting Gravel in River Beds

By H. H. Cartwright*

SYNOPSIS—The injection of cement into sand and gravel to form concrete in place has been suggested many times and has been employed in some cases. The accompanying article describes some interesting experiments made with such a process for the purpose of ascertaining the possibility of its use for forming foundations of bridge piers, etc., in river beds composed of sand and gravel deposits. They are perhaps the most extensive experiments of the kind that have been made.

❖

In the whole field of civil engineering construction there probably is no greater opportunity of effecting economy than by reducing the cost of masonry foundations, where solid rock cannot be found at a suitable depth. The customary caisson and coffer-dam methods are expensive, as is also the spread-footing method, where only soft material can be found. A process experimented with at Nashville, Tenn., during 1912, was that of forming a foundation stratum at the proper depth by forcing cement grout into the soft foundation material by means of compressed air.

The Foster-Creighton-Gould Co. was fulfilling its contract to build a new bridge, about 2800 ft. long, across the Cumberland River at Nashville for the Louisville & Nashville R.R. The location is at a point on the river known as the "Nashville Island." This island is a gravel bar, which during low water has an area of about eight acres. The thickness of gravel is from 12 to 24 ft. to bedrock. It was decided that this point would be an excellent place to carry on investigations to determine whether gravel in place could be solidified sufficiently to support heavy structures. Therefore the above contractors were requested by the railroad company to do the work and the writer was instructed to supervise and report.

Before attempting any experiments, all the information that could be obtained readily was studied, but this information was scarce. It was found that in possibly two or three instances successful jobs had been made by forcing cement into crushed stone under a head of water, where it would have been impossible to have deposited concrete in the usual way, due to the inaccessibility of the work. In all cases perforated pipe had been buried in the stone and enough cement grout had been injected to fill the voids, thereby making a solid concrete. But as far as known, to make concrete by forcing cement through pipe driven into a natural gravel bar had not been attempted.

Knowing that the theory of making good concrete is to thoroughly fill all voids in the aggregate, the problem was to find out how nearly this could be approached by the proposed method when the voids in the gravel are already filled or partially filled with silt and fine sand, as is nearly always the case in a sand and gravel bar. It was also desired to determine under what head of water it would be possible to eject grout from the pipe, and to compare the concrete formed at the various depths.

One foreman and his gang, with the necessary machinery and other equipment were kept on the experiments 3½ months. Every possible condition was tried out in nine experiments. Several of these were minor tests made simply to gain sufficient working knowledge to proceed with those made on a larger scale.

Equipment

The equipment essential is that for mixing the cement, conveying it and forcing it out, driving the discharge pipe and pulling the pipe. On the first test the outfit was rather crude, but was constantly varied as we proceeded and as improvements suggested themselves. An air compressor capable of supplying 100 cu.ft. of air per minute and an air reservoir of 30 cu.ft. capacity furnished air for mixing, conveying and forcing the grout.

The grout was mixed first in mortar boxes, and later in a MacMichael pneumatic concrete machine.† For the first test, an air drum, made at a local shop, was used. This consisted of a 36-length of 12-in. pipe, capped at the bottom, with flap door at top operated by hand, and having in the drum three openings (one discharge and two inlets). The grout, having been mixed, was poured into the drum, the flap raised and air turned on for forcing out. A pressure indicator was attached so that it would be possible to note by the action of the needle whether the batch had been discharged. The drum was later used in connection with the pneumatic mixer, which did the mixing while the drum provided for the conveyor. The pneumatic mixer is a drum of 8 cu.ft. capacity, having a discharge opening at bottom and two air inlets, one for mixing and the second for discharge pressure; the former inlet is located at the bottom of the machine and the latter near the top. When the flap door at the top is open the air entering at the bottom of drum causes

*Assistant Engineer, Louisville & Nashville R.R., Winchester, Ky.

†"Engineering News," Aug. 10, 1911.

the cement and water to "boil" violently, thereby thoroughly mixing the ingredients. Later on, the small drum was discarded when it was found that the MacMichael machine would do both the mixing and conveying. This machine is shown in Fig. 1.

Black pipe, of 2-in. diameter, was used for driving into the bar. A standard well point, Fig. 2, screwed into the lower end of the pipe, served as a drive shoe and the perforations in the point afforded discharge area. The pipe is objectionable due to its inability to withstand the driving and pulling strains. This was supplemented

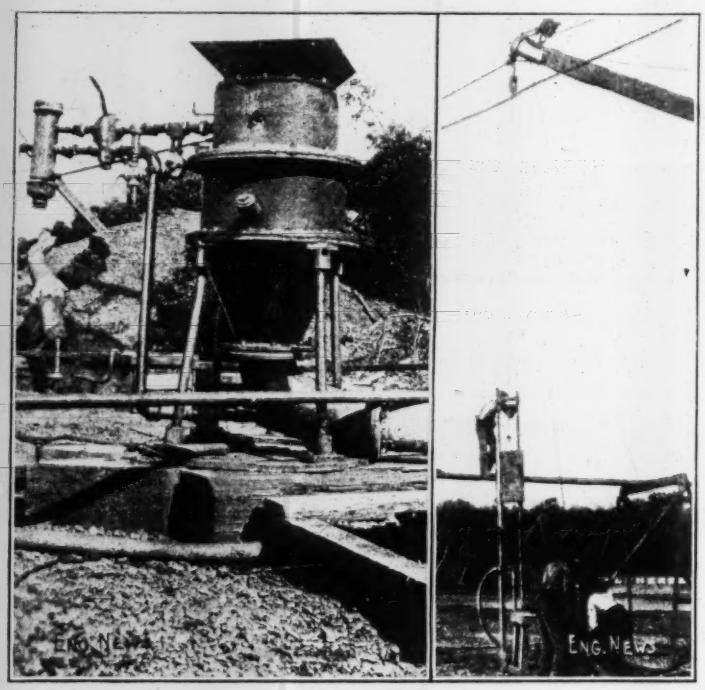


FIG. 1. PNEUMATIC DEVICE FOR MIXING CEMENT GROUT AND FORCING IT INTO GROUTING PIPES

FIG. 3. DRIVING 2-IN. GROUTING PIPES WITH A HAND-OPERATED HAMMER

by a set of hollow steel drill rods which were stiff enough to be driven with a 1000-lb. hammer. With this outfit the driving problem was solved, but the inside bore of the rods was so small that the grout could not be forced through rapidly enough to make their use practicable, therefore the 2-in. pipe was again resorted to. For pulling the pipe, long timber levers were used at first, but as this was a slow method, a derrick and hoisting engine were substituted. The best rig used for driving the pipe was a 175-lb. wooden hammer in leads. The hammer was operated by men pulling a line attached to the hammer and run through a sheave on the derrick boom overhead, as shown in Fig. 3.

FIRST EXPERIMENT

The following experiment was made at a point on the bar where bedrock was 23 ft. below the surface and where water level was 8 ft below. In order to be able to view the concrete, the grouting was done on the circumference of a circle, and the center core of gravel afterwards excavated. By this method a buried hollow cylinder of concrete was formed. An analysis of the gravel indicates the following proportions: coarse gravel, 12%; very fine gravel, 34%; sand, 44%; silt, 10%. This shows that the conditions were very severe. Since concrete of fair quality was made from the above described aggregate, there is no doubt that very good concrete can be formed in the average gravel bed.

As shown in Fig. 4, 16 pipes (2-in. black pipe), approximately 3 ft. apart, were driven into the bar on the circumference of a 15-ft. circle. Each pipe was in four sections, each section 5 ft. long with a standard well point 2.5 ft. in length screwed into the lower end. The pipes were all driven to rock, and were kept open while being driven by means of water and air hose. Water was turned into the pipe through one of the hose and forced out by the other hose carrying air from the drum. Cement grout was supplied to each pipe on the assumption that around each one should be formed a cylinder of concrete 4 ft. in diameter. The perforations in each well point covered a length of 1.7 ft., therefore to inject five sacks of cement each time the pipe was raised 1.7 ft. should have given a solid wall of good concrete.

Around the drum was built a 10x10-ft. platform, 4 ft. high, on which were placed mortar boxes. This method of mixing was very tedious so we connected an air line to the MacMichael machine and used it as a mixer, conveying the grout to the drum by air. An indicator on the air machine served to tell whether the batch of grout was being discharged, or whether the drive pipe was clogged. An average pressure of 20 lb. was sufficient, but often 60 lb. would not clear the pipe. In this case it was necessary to insert into the drive pipe a small water hose and jet the well point. One batch of grout was made of 1 sack of cement and 3½ cu.ft. of water, which mixed almost instantaneously in the pneumatic machine to a consistency of rich cream.

With all the pipes driven to rock, the grout hose was attached to each successively and the proper amount of cement shot in. Then each pipe was raised. This process was followed until all the pipes were extracted from the ground, except those that could not be pulled and had to be abandoned. When any pipe was left open at the top and air was turned into another, water was forced out of the open pipe, sometimes 40 ft. high. This indicated that there was good underground communication. This would occur at a pipe 10 ft. from the one through which air was being admitted.

There were 582 sacks of cement used with this test. It took eight men five days to deposit roughly 120 yd. of concrete, because the minor difficulties were many. Pulling the pipe gave more trouble than anything else. Four men using a 20-ft. lever (a 6x6-in. timber) pulled the

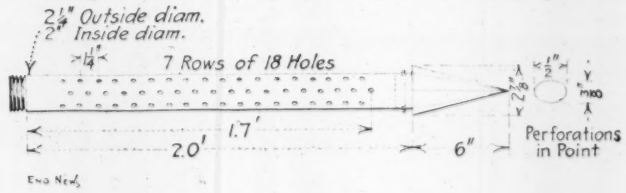


FIG. 2. WELL POINT ON END OF GROUTING PIPE

pipe, but the process was slow. Several pipes were broken off due to threads stripping.

The ground water level was 8 ft. below the surface of the bar. After the pipe was raised to this elevation it took only about 15 lb. pressure to eject the grout. It could be seen that the grout was covering the entire area of the circle, as the gravel near the center quaked noticeably. Injecting the grout below the water level had compacted the sand and gravel, which had sunk, leaving at the water level a very porous layer that could be easily

penetrated. At this level was found the best concrete. When excavation was started, practically no concrete was struck until a depth of 4 ft. was reached, and from four to eight feet was solid clear across. It was very hard to break this out with picks. The concrete was in reality a cemented gravel and was not very well bonded, due to a film of mud surrounding each stone of the

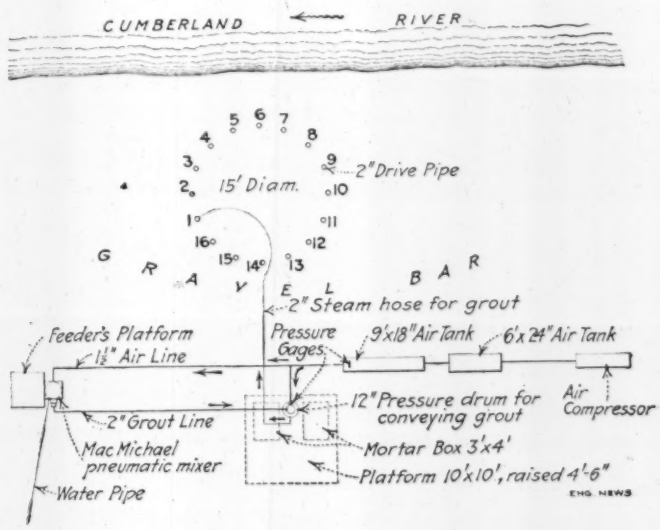


FIG. 4. PLAN OF PIPES AND PLANT FOR GROUTING GRAVEL IN PLACE

gravel. However, it set very hard later, and would have made a strong foundation. Below the water level the concrete was not nearly so good, but was irregular and resembled large clinkers. Many leaks sprung in the walls, but with a pulsometer the water could be pumped down within 2 ft. of the rock.

The test was of value, in that it showed that cement could be forced out at a depth of 23 ft. below the surface

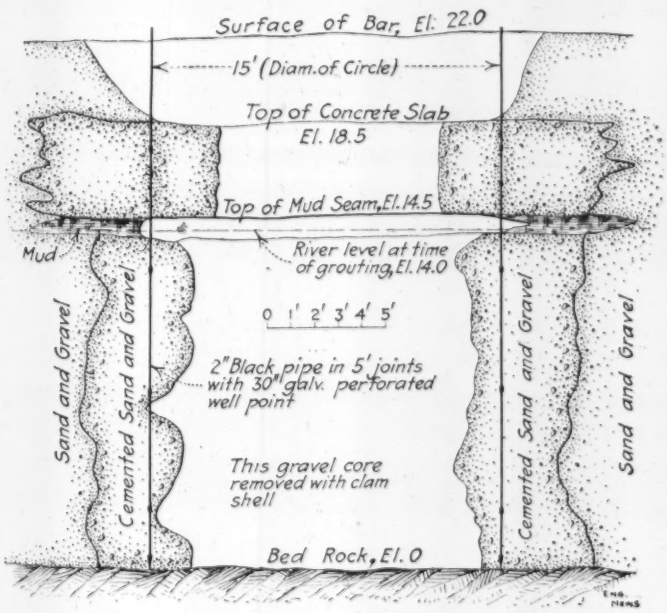

Surface of Bar, El. 22.0
15' (Diam. of Circle)
Top of Concrete Slab
El. 18.5
Top of Mud Seam, El. 14.5
Mud
River level at time of grouting, El. 14.0
0 1' 2' 3' 4' 5'
2" Black pipe in 5' joints with 30" galv. perforated well point
Sand and Gravel
Cemented Sand and Gravel
This gravel core removed with clam shell
Cemented Sand and Gravel
Sand and Gravel
Bed Rock, El. 0
ENG. NEWS

FIG. 5. TYPICAL CROSS-SECTION OF CONCRETE CYLINDER FORMED BY THE CIRCLE OF GROUTING PIPES

of the bar. But the difficulty was, that the grout would take the path of least resistance, which was upward, and would not spread laterally far enough to make a very tight wall. Fig. 5 shows the conditions approximately as they were after the hole was excavated, and Fig. 6 illustrates the results of the test.

SECOND EXPERIMENT

The next experiment attempted was to work under a head of 57 ft. of water. Since the maximum depth of gravel was 15 ft. below the river level, it was necessary to erect a steel tank and fill it with sand and gravel. Therefore a concrete base was made and a tank 6 ft. square and 60 ft. high was erected on it. The tank was made of Gould sheet piling, seven channels on each side.

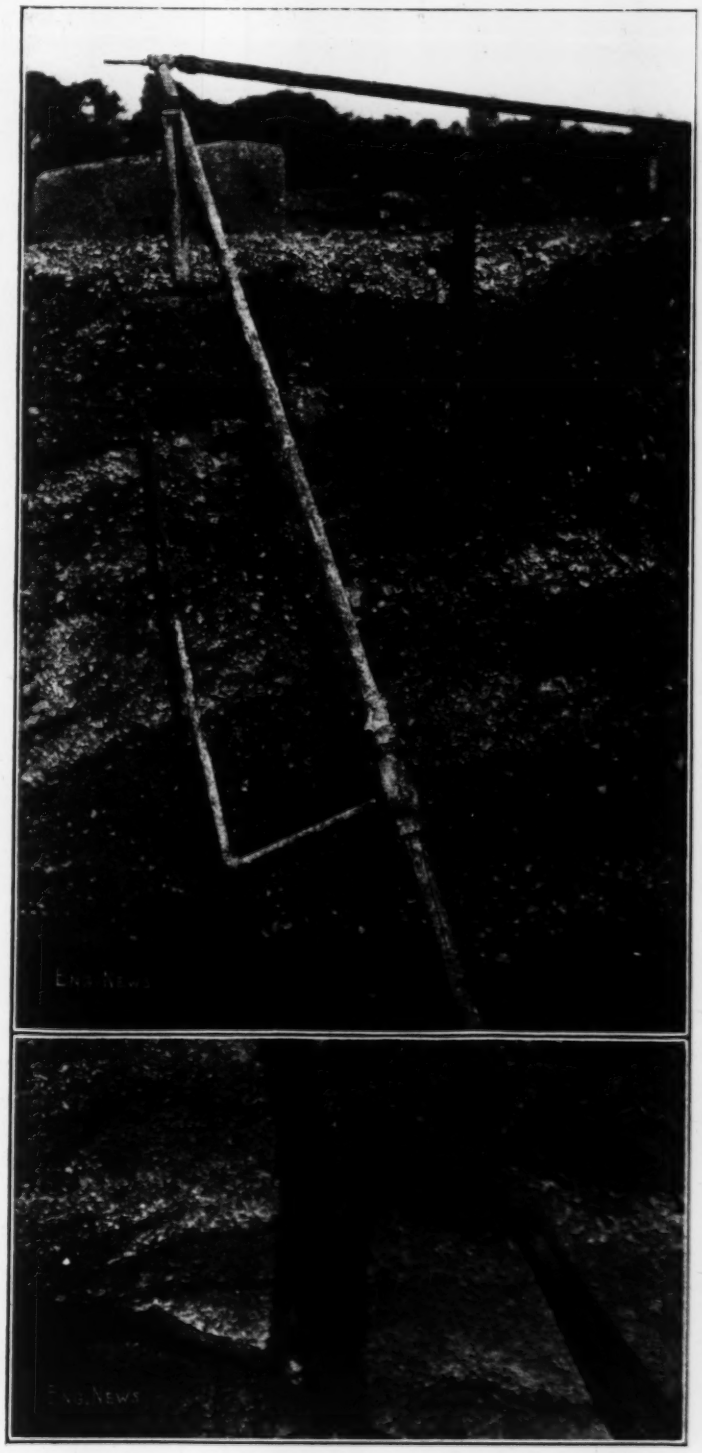


FIG. 6. FACE OF GRAVEL AFTER GROUTING

(The upper view shows the top of the pit, with grouting pipes. The lower view shows a patch of dense grout, also the ordinary grouted gravel and a seam.)

Concrete was placed inside on the bottom to seal the tank so that it would hold water. Sand and gravel, excavated from the bar near-by, was placed in the tank until it was half filled. Before filling, five 2-in. pipes 60 ft. long, with well points screwed into the lower end, were placed in the tank, arranged as shown in the left-hand view in Fig.

7. These were spaced uniformly so that each pipe could grout the same quantity of sand and gravel. The tank after completion is shown in the right-hand view in Fig. 7.

Three water lines were turned into the tank, one 1½-in. and two 2-in. It took several days for the wood packing in the piles to swell sufficiently to prevent leakage, but it finally became watertight, then the water level was kept within 3 ft. of the top. There were 40 cu.yd. of sand and gravel in the tank. Five sacks of cement were forced through each pipe, then they were all lifted 2½ ft. and the grouting repeated. This was continued until 200 sacks of cement had been used. It was computed that 40 lb. pressure should clear the pipe at a depth of 60 ft., but it took from 70 to 80 lb. Every blow brought cement to the surface of the water and caused it to boil up and occasionally splash out of the tank. Before quitting for the night, the pipes were all raised several feet above the last shot of grout. Then 48 hours elapsed before work was resumed. On returning, all of the pipes were stopped up and could not be pulled. All water was let out of the tank and the pipes were unjointed at the top of the gravel. For 10 ft. above the gravel, cement was set up solid in the pipes.

FIG. 7. EXPERIMENTAL 60-FT. STEEL TANK (6x6 FT.) FOR TESTING THE GROUTING OF GRAVEL AND CEMENT

(At the left is the interior of the bottom of tank, with one side removed to show the grouting pipes and well points. The horizontal rods are stay-bolts holding the sides of the tank together. At the right is the completed tank.)

After the cement in the water had precipitated, it was found that the tank contained 33 ft. of material. An 18-in. layer of gravel was put in; then 7 ft. of clean sand, 3 ft. of gravel, 2½ ft. of sand and 5½ ft. of gravel, as shown in Fig. 8. Only one pipe was driven into this material, and this was in the center of the tank. Much trouble was had in keeping the pipe open, since the sand would cave into the well point through the perforations. When it did so, a ¾-in. hose was lowered into it and the sand removed; however, this operation was necessary so often that the entire pipe was taken out and the point wrapped with No. 10 mesh wire screen which remedied the trouble.

There were 25 sacks of cement in grout placed at 27 ft. below the top of the tank; 25 at 24½ ft., 15 at 22 ft., 10 at 19½ ft. and 20 at 17 ft. Finally 3½ ft. of crushed stone was placed in the tank; 47 sacks of cement were injected into the stone, 35 being in the center and six at the north and south sides. The stone possessed 37% of voids, which were completely filled with cement.

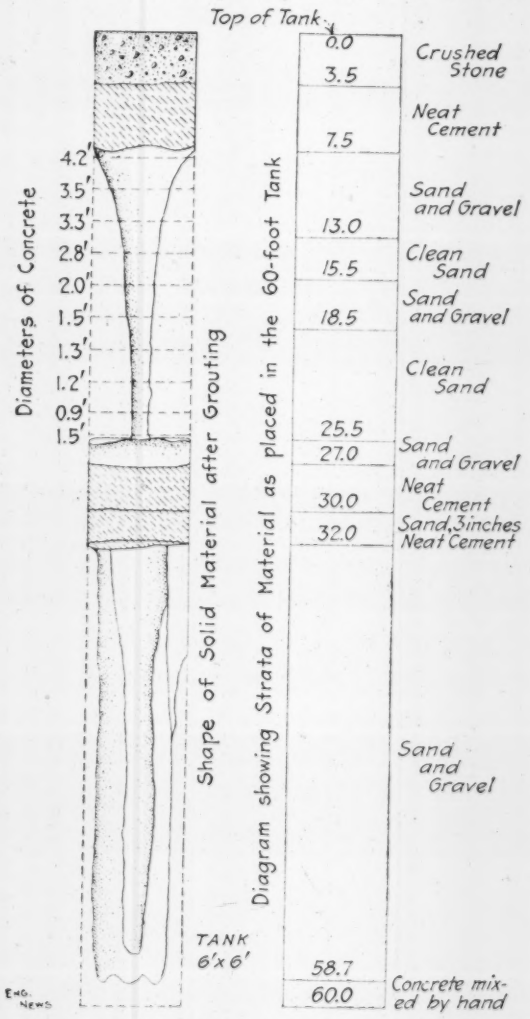
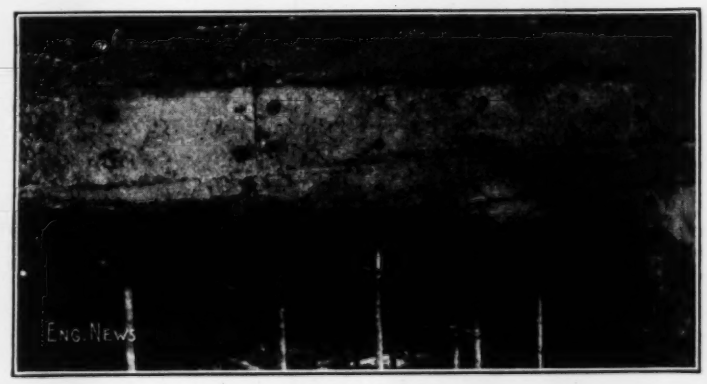


FIG. 8. SECTIONS OF MASS OF CONCRETE FORMED BY INJECTING CEMENT GROUT INTO TANK FILLED WITH SAND AND GRAVEL

The last cement was placed in the tank on Sept. 27 and on Oct. 9 the tank was thrown over by jacking up one side. As the sides were removed, it appeared that very little of the material was solid, except the stone concrete at the top, and that neat cement had found its way to the sides in thin veins. After the sides were removed all loose material was stripped off and only the solid stuff left. The lower half of the tank contained good concrete, about 66% of its volume. Above this was a layer of neat cement 3 to 5 ft. thick. Through the sand, where only one pipe was used, the concrete was only 12 in. in diameter, and increased in size toward the top. Fig. 9 illustrates the shape of the concrete in the entire 60-ft. length of the tank and in its upper portion; also a portion of the cement skin and good concrete against the steel side of the tank. The stone concrete was perfect, and became very hard after it had set awhile. All the concrete in the tank set and was very difficult to blast to pieces. The stay-bolts of the tank

were embedded in the concrete and reinforced it to such an extent that it was hard to blast off the concrete so that the bottom side of the tank could be removed.

From this test it was learned that cement could be forced into gravel under a head of 57 ft., with no more difficulty than at a depth of 10 to 20 ft.; that in a small tank, there is no way for the air to escape laterally, but it must go up and consequently carry with it much cement. Comparing results in stone, in sand and gravel,



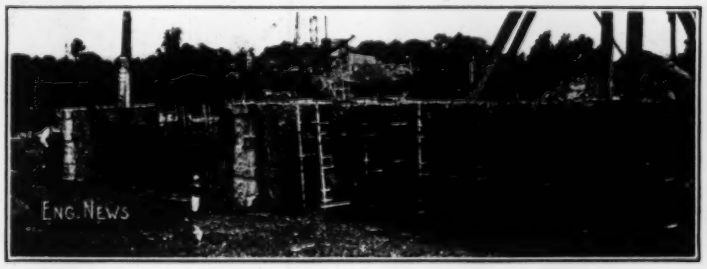


FIG. 9. CONCRETE FORMED IN TANK; AFTER REMOVAL OF THE SIDES AND THE LOOSE MATERIAL

(The top view shows the concrete of the entire 60-ft. height of tank, the tank having been thrown on its side. The middle view shows the concrete in the upper 25 ft. of the tank. The bottom view shows part of the cement and concrete against the steel side of the tank.)

and in sand, the best results are obtained where the per cent. of voids is largest.

THIRD EXPERIMENT

Following the experiment just described, two tanks of the same cross-section but only 20 ft. high, were erected and filled with sand and gravel from the bar. Grout pipes were driven on closer centers and a larger quantity of cement per yard of gravel was used, thereby more nearly filling the tank with concrete. Fig. 10 shows the results.

METHODS OF WORKING

In practice, success will be attained with this process by overcoming the many minor difficulties which arise, so that work may be done accurately and rapidly; assuming, of course, that the material to be grouted is fairly suitable. Otherwise, the cost cannot be reduced and the results will not be so good as by the present practice.

Since it is necessary to fill the voids in the material to be solidified, with the solid contents of the grout, it requires about three times the quantity of grout that it would be necessary if the voids were to be filled merely with grout itself, because 75% of this is liquid. The principal difficulty with the whole process is to get rid of the excess water required, without, at the same time, washing the cement out of the gravel. In the tanks there was no way to prevent this water from flowing over the top, since they were watertight. It seems that the grout working its way upward through the gravel on the river bed would lose its cement and come to the surface as water, but in the tanks 6 ft. square it did not, but came out as rich as it was in the mixer. There is no reason, in a large sheet-pile enclosure, why the excess water should not be taken care of through the bottom, because there is sufficient room for the air to leave the water quickly and lose its energy laterally through the voids of the material in the dam, thereby allowing the water to seep out gradually, following the air and not being pushed upward with it as in a small enclosure.

In the open bar, the cement spreads out in wide thin ledges, taking what paths of least resistance it can find. Therefore, the gravel should be inclosed by piling or by grouting a wall around the proposed foundation and later working forward the center. After a pipe is driven below the water level, the air coming out vertically starts

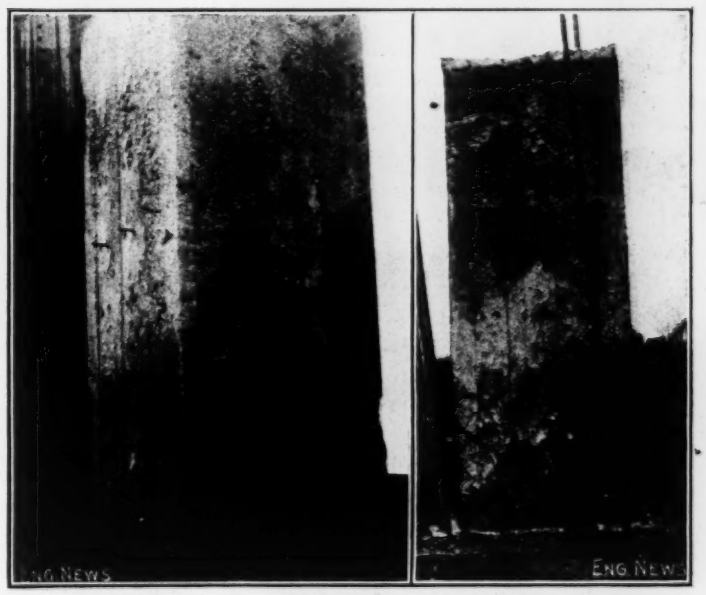


FIG. 10. CONCRETE FORMED IN TANK 20 FT. HIGH (6x6 FT.) BY INJECTING CEMENT GROUT INTO THE GRAVEL FILLING

the ground-water circulating upward, which will bring with it to the water level some of the mud and silt in the bar. A mud seam always results, if the material to be grouted is dirty.

Excessive air pressure is damaging, because it removes a large quantity of the cement already deposited and forms a concrete that is irregular in structure, resembling clinker. When the pipe clogs, instead of using a high pressure to open it, it is better to lower a water hose into the pipe and jet out what stuff is in the way. It is best to have a compressor large enough to keep in the air

reservoir a minimum pressure of 80 lb. so that a strong jet of air will always be playing through the mixing line at the bottom of the drum. If not, cement will get into the orifice of the mixing jet and set, decreasing the size of opening until there is not enough current to cause a violent ebullition in the drum. Then the grout will not be thoroughly mixed and cannot be forced out.

The size of the perforations in the grouting point should be governed by the quality of material to be grouted. In coarse gravel there should be large openings, and in sand small ones; they should be just small enough to prevent the sand or gravel from falling through to clog the point. Unless it is absolutely certain that the cement and sand are free from large stuff, it should be screened to prevent anything going into the grout that will stop up the perforations in the well point.

A strong current of air should be held through the mixer and pipes while driving the pipe down into the bar, in order to keep out the finer material that otherwise would crowd into the point. The drive pipe should be heavy enough to stand driving with a big hammer. Much time was lost in driving because of the pipe bending and the threads stripping.

Conclusion

The results of the experiments show concrete from the poorest grade to that as good as class A. The worst is a cemented gravel, very poorly bonded. The best is a very hard concrete, so perfectly bonded that when fractured the siliceous gravel stones or pebbles are broken along with the mortar. Not a single perfect job was made with any of the nine experiments. There were noticeable defects in all; some could not be avoided on account of the dirty material; the others could have been avoided but for the lack of knowledge which was gained on the later experiments.

There is no doubt but that safe foundations can be made by this process. Test borings should be made at the site of the proposed structure to determine the quality of the material. If it is found to be clean and coarse, there is nothing to prevent an excellent foundation being made. After the grouting is finished, in order to be assured that the job is good, borings should be made into the concrete to determine its solidity.

Since from the results of the experiments, it appears feasible to form hard foundation strata on which to found masonry structures, this process should also prove of value in solidifying the river bed around piers and dams already constructed, where scour from the stream is damaging.

NOTES FROM THE ENGINEERING SCHOOLS

University of Georgia—The following notes on the good-roads winter school recently held have been received.

The only charge was a registration fee of $1. The courses given were as follows: (1) Methods of determining the suitability of local road-building methods (sand and clay); (2) principles of road location and relocation; (3) selection of proper materials for concrete construction; (4) best methods of constructing permanent culverts; (5) methods of mixing and placing concrete for piers, abutments, etc., and best proportions to use; (6) construction and maintenance of earth, sand-clay, and top-soil roads, and the utilization to best advantage of local materials.

Ten counties were represented, some by three and most by two delegates. Much interest was manifested in the school, and it is expected to become an annual event. The sessions extended in 55-minute periods from 9 a.m. to 1:50 p.m., and in one laboratory period from 3:10 to 5 p.m. On one day the entire school was taken over the top-soil roads east of Athens; the trip concluded by the re-location of nearly one-half mile of road to replace a mile of wretched washed-out road, with mud holes, 10% grades, etc. First an approximate line was run with the planetable; then it was readjusted, levels were taken and the road was staked out for construction.

Columbia University—Radical departures have been made in the development of courses in chemical engineering of the School of Chemistry (which now, with the Schools of Mines and Engineering, is a post-graduate department requiring a college degree for admission). The organization of the new course and the work attempted were described at length by Prof. M. C. Whittaker before the New York section of the American Chemical Society, Mar. 7, 1913.

It was believed at this institution that modern manufacturing processes, based on chemical phenomena, were advancing at a rapid rate and were calling for men trained to develop and direct work which was as much engineering as chemistry. It was felt that most schools had not approached, in the best way, the problem of producing the needed men. Under the advice of Prof. Whittaker, himself formerly a practising chemical engineer, it was decided to teach directly the use of engineering methods and processes in the solution of chemical problems rather than to confine students to the manipulation of the usual chemical laboratory equipment. This was held to be in line with the development of modern mechanical- and electrical-engineering laboratories, where commercial equipment was employed rather than apparatus typical of the pure-physics laboratory which would allow the investigation of basic principles only.

The new industrial laboratories for this course occupy now the whole lower floor of Havemeyer Hall, and only a beginning has been made. Besides a general laboratory, there are now electro-chemical, textile, paper, fuel and several research laboratories, as well as a machine and a pipe shop, a grinder and a furnace room, etc. The general industrial chemical laboratory contains typical commercial equipment such as filter presses, pressure and vacuum pumps, siphons, solution tanks, agitators, samplers, vacuum dryers, pot and column stills, steam-jacket evaporators, condensers, centrifugal dryers, clarifiers, gasholders, and gas-welding apparatus. A dye laboratory has a calico printing machine, among other things and an equipment of microscopes and ultra-microscopes. The paper laboratory has an iron soda digester, a bronze sulphite digester, a pulp beater, mechanical stirrers and drum dryers.

The student's work is done in squads of four or five, with one man acting as foreman. The problems assigned involve cyclic processes as far as possible in order to reduce cost and to avoid the accumulation of end products. In research work, such problems are given as are

met with in transferring operations from the test-tube and beaker stage to a factory scale. So far as possible, the work is on a quantitative basis with accounting for all losses at each stage. The squad foreman has to prepare in advance a general preliminary report on the chemistry and practical procedure of an assigned problem. Each man, however, has to present a detailed final report of the entire work covered. The instructors assign work and supervise processes, but do not arrange the work for students in detail or assist them in it. It is reported that the men soon learn the limitations of the necessary commercial apparatus and acquire engineering judgment and facility of application. No attempt, however, is made to develop skilled operators.

❖

An Earthquake extending from Ottawa to Montreal in Canada and through Western New York occurred on Apr. 28. The shock was felt principally in Ottawa, but little or no damage was done in any locality.

A Butting Collision between an extra freight train and a passenger train on the Chicago, St. Paul, Minneapolis & Omaha Ry., at Baldwin, Wis., caused the deaths of two railway employees on Apr. 27. The wreck is reported to have been due to a misunderstanding of train orders.

The Explosion of an Oil-Fuel Tank on the new Hamburg-American steamship "Imperator" is reported to have killed two workmen and caused fatal injuries to three others on Apr. 22. The explosion is said to have been caused by one of the workmen's cigar lighters.

A Blasting Accident at the quarries of the Riverside Portland Cement Co., Riverside, Calif., on Apr. 23, caused the deaths of 12 men, including the powder foreman. It is reported that two 500-lb. charges of dynamite were prematurely exploded in some unknown way. Six other charges in the same hill were not exploded.

An Explosion of Fulminate of Mercury at the United States Arsenal in Philadelphia, Penn., caused the death of a workman and completely wrecked the drying house, on Apr. 28. The workman was the only person in the building at the time, and it is supposed that he dropped a tray of loaded detonators.

The U. S. Wireless-Telegraph Licenses, issued during the first four months of operation under Federal regulation (to Apr. 13, 1913) number 3407 for both operators and stations. There are 46 American ship stations and 18 coast stations, with 685 amateur stations. The first-grade commercial operators number 1279, second-grade, 186; there are registered 1185 amateurs and eight operators of experimental and instructor grades.

A Railway Valuation Committee has been organized by the Norfolk & Western Ry., for the purpose of devising a plan of valuation of the company's property under the Act of Congress approved in March. The committee will afterward carry on the work of valuation, and as this will extend over a considerable period of time the officers composing the committee have been relieved from their present duties. These officers are the following: Charles S. Churchill, Chief Engineer; W. S. Battle, Jr., General Claim Agent, and J. M. Rodgers, Statistician. Their regular duties will be assumed by Jos. E. Crawford, Acting Chief Engineer; J. B. Baskerville, Acting General Claim Agent, and W. B. Moss, Acting Statistician.

In the Flood Cleansing Work at Portsmouth, Ohio, the city authorities agreed upon a plan to facilitate the cleaning of rented houses which was thus stated in an order issued by Dr. S. B. McKenihan, health officer:

> All persons occupying property as renters will be allowed one-half month's rent free, and if living off the commissary, will be compelled to clean their premises at once. Failure to comply with this will be sufficient cause for ejectment. . . . All property owners collecting rent and failing to agree with this arrangement will be required to clean their premises themselves or subject themselves to arrest.

Assistance for Electric-Supply Companies in flooded districts is being extended by the National Electric Light Association. A special committee, of which C. L. Edgar, of Boston, Mass., is chairman, has been appointed and given full power to assist member companies in the troubled regions by placing at their disposal men and material needed for the prompt restoration of service. The committee is not undertaking the general relief of employees, but states that it wishes to be advised of special cases in which it could be of particular service even for the lowest-paid employees.

A Reinforced-Concrete Building Survived the Flood in Dayton, Ohio, according to information received from W. W. Smith, Special Field Agent for the Association of American Portland Cement Manufacturers. The building was exposed to the fire of closely adjacent buildings while the water was at its height, and served as refuse to several hundred persons. Its windows, not wire-glass, were much damaged, but all combustibles were removed from the exposed side by the people in the building in time to avoid transmission of fire. The building is interesting because it was the first reinforced-concrete building constructed in Dayton. It is the Beaver Light & Power Bldg. No. 1, and is 170x204 ft. in plan, five stories high. Schenck & Williams, of Dayton, were the designers and O. P. Hazen & Co., Dayton, the builders. Much difficulty was found at first in renting it, on account of its novelty. During the flood the water was 14 ft. above ground at the building, and flowed through the first story with such rapid current as to tear out the Mackolite partitions and carry away the contents of the first story, including a 2-ton safe.

Highway Bridge Damage in Indiana has been summarized by the Bridge Committee of the Indiana Enginering Society (ch., Alex. R. Holliday, Indianapolis). The estimate is that about $1,000,000 worth of damage to highway bridges was done by the floods of Mar. 24-27. This figure is based on returns to letters of inquiry from 41 out of 92 counties, these 41 counties returning a total of $716,135. Out of the 41 counties, 16 report no damage, while four report damage slightly over or under $100,000. The summary as to kinds of bridges indicates that numerous concrete bridges went out as well as many steel bridges, but the concrete bridges are of considerably smaller span, on the average.

9 wooden bridges	$25,300
79 steel bridges	641,400
2 stone bridges	7,000
20 concrete bridges	42,435
Total	$716,135

DAMAGE TO INDIANA HIGHWAY BRIDGES, EASTER FLOOD, 1913

	Kind of Bridge				
County	Wooden	Steel	Stone	Concrete	Amt. Damage
Adams	..	1	..	..	$3,000
Bartholemew	..	7	..	2	19,400
Benton	..	2	..	2	5,500
Boone	..	2	..	3	8,485
Clay	..	1	..	..	300
Cass	1	3	..	..	85,000
Delaware	2	7	..	5	26,850
Elkhart	..	..	..	none	
Fountain	..	3	..	..	2,000
Franklin	..	..	..	1	10,000
Grant	..	5	..	..	30,000
Hamilton	1	..	..	..	4,000
Hancock	..	19	..	1	25,000
Hendricks	..	1	..	..	900
Huntington	..	1	..	1	10,000
Jackson	..	..	..	none	
Johnson	..	..	1	2	8,500
Lake	..	..	..	none	
LaPorte	..	..	..	none	
Marion	..	3	..	1	190,000
Marshall	..	..	..	none	
Montgomery	..	..	..	none	
Miami	..	3	..	..	50,000
Morgan	..	1	..	..	2,000
Madison	1	..	..	..	4,000
Noble	..	..	..	none	
Ohio	..	..	..	none	
Orange	..	..	..	none	
Owen	..	..	..	none	
Parke	..	1	..	1	4,950
Pike	..	6	..	..	4,350
Porter	..	..	..	none	
Putman	..	..	..	none	
Pulaski	..	..	..	none	
Randolph	3	3	..	..	5,400
St. Joseph	..	..	..	none	
Shelby	1	3	1	1	125,000
Tippecanoe	..	2	..	..	90,000
White	..	5	..	..	1,500
Whitley	..	..	..	none	
Washington	..	..	..	none	
41 Counties					$716,135

The Ohio Canal at Cleveland—The Ohio Canal suffered extensive damage in the Cuyahoga River valley between Akron and Cleveland. While it has had little or no navigation use in recent years, the question of its official abandonment is quite uncertain, on account of sentiment against closing the state canals. At Cleveland, where the canal extends along the east bank of the river, a long stretch of the canal is an obstruction to the best development of the valley lands. The two-mile length below the Denison-Harvard viaduct lies between the river and a broad area of low-lying land valuable for industrial development if contiguous to the river. Various uses of the canal water at Cleveland bring the state a revenue

of several thousand dollars annually; the canal is now being repaired, at least sufficiently to maintain these water services.

River improvement at Cleveland as part of the canal connection from Lake Erie to the Ohio River was put in prospect by Congressional action of two years ago, authorizing a survey of the river for its improvement to a connection with the Ohio Canal. A report has been rendered, but no further action has been taken as yet, pending the establishment of a coöperative arrangement between the Government and the city.

A New 1000-Ft. Municipally Built Pier is to be erected on the Hudson River at the foot of West 46th St., in Manhattan Borough, New York City. The estimate of the cost of this pier is $2,735,000. Similar piers are called for by the present plan at the foot of West 44th and at the foot of West 46th Sts., but they are not to be immediately built. Hearings on the condemnation proceedings in connection with the new work will be held May 21.

Bids for Enlarging the Power Canal of the Montreal Water-Works will be received until May 16 by the Board of Commissioners of Montreal, P. Q. The canal (locally known as the aqueduct), forebay and tailrace will be widened and deepened for a length of about 31,000 ft., involving some 2,350,000 cu.yd. of earth excavation, 436,000 cu.yd. of rock excavation, and the construction of about 203,000 cu.yd. of concrete retaining side walls, some of which will be reinforced. We are unofficially informed that the estimated cost of the work is $2,000,000, besides which the city has already spent and is engaged in spending some $4,000,000 for a conduit paralleling he aqueduct, a pumping plant and a filtration system. T. W. Lesage is chief engineer and superintendent of the Montreal Water-Works, and L. N. Senecal is secretary of the board of commissioners.

A Water-Power Plant under a 5412-ft. Head is under construction near Martigny, Switzerland, according to a bulletin from the firm of Thyssen & Co., Mülheim a. d. Ruhr, Rhenish Prussia. This plant is being designed by M. Boucher, of Lausanne, for the Société d' Electrochimie, of Paris. Water is taken from Lake Fully; this is near the valley of the Rhone, where the mountain sides descend precipitously to the river valley.

The pipe line will be about 2¾ miles long, having inside diameters of 19⅛ in., and 25⅝ in., with thicknesses of from $^{15}/_{64}$ in. to 1$^{35}/_{32}$ in. The upper section will be of lap-welded pipe, while the lower sections will be of seamless drawn tube. The construction of the pipe line has been placed with Thyssen & Co. Turbines, for 15,000-hp. capacity, will be built by Piccard, Pictet & Co., of Geneva.

An Engineering Commission on Electric Traction for steam railways was again proposed by Frank J. Sprague, of New York City, before the New York Railway Club on Mar. 21. He stated that if such a commission was organized, with engineers of the highest standing and without need of limiting the time to be devoted to their studies on this question, then the electrical interests of the country would pay part or all of the expenses. He expected that the electrical manufacturing and supply companies would combine in financing some organization which would furnish rolling stock and energy on a basis of payments in accordance with the use of the former and the metered electrical loads.

Electric Traction Will Supplant Steam on a mountain section of the Norfolk & Western Ry., it is announced. This step is to be taken to relieve congestion on 30 miles of line over the Alleghany summit, between Bluefield and Vivian, W. Va. While it is not announced whether alternating or direct current will be used, yet it is reported that overhead trolley wires will be necessary on account of large yards and lines at grade through several mining towns. Locomotives will be used and the equipment will be designed more for freight than passenger service on account of the great excess of the former.

A Comprehensive Rapid-Transit Subway System is planned for Philadelphia by Transit Commissioner A. M. Taylor. There is at present in service a single two-mile east and west line through the center of the city along Market St., from the Delaware River to the Schuylkill, with an elevated extension for three miles beyond. There would be according to the new plans also (1) a four-track line from the center of the city, running north on Broad St. some 3¼ miles to Allegheny Ave., with a two-track extension three miles to Olney Ave., (2) a two-track line south on Broad St., 2½ miles to Oregon Ave., with chance for extension to League Island, 1½ miles, (3) a two-track terminal loop through the heart of the city, (4) elevated lines to Frankford (six miles northeast of City Hall) and Darby (seven miles southwest). The cost of construction is placed at $30,000,000, and that of equipment at $8,000,000 more. Enabling legislation to permit of financing the project through taxation, assessment and bond issues, is being sought from the legislature by the city administration.

PERSONALS

Mr. John N. Carlisle, a lawyer, of Watertown, N. Y., has been appointed Commissioner of Highways of the State of New York.

Mr. Charles D. Lay has resigned as Landscape Architect of the Department of Parks, Borough of Manhattan, New York City.

Mr. Lawrence Hanlon, for some years Assistant Superintendent of Municipal Ferries, New York City, has been promoted to be Superintendent, succeeding the late W. J. Sears.

Mr. F. W. Stevens, Chairman of the Public Service Commission of New York State, Second District, has resigned. He has been Chairman since the organization of the commission in 1907.

Mr. R. R. Potter, former Assistant Editor of "Engineering News," has been promoted from the position of Asssitant Superintendent to be Production Engineer of the Blood Bros. Machine Co., Kalamazoo, Mich.

Mr. P. Coniff, formerly Master Mechanic of the Baltimore & Ohio R.R., at Cumberland, Md., has been promoted to be Superintendent of Shops at Mt. Clare, Baltimore, Md., succeeding Mr. J. W. G. Brewer, promoted, as noted elsewhere.

Mr. A. J. Wharf, M. Am. Soc. C. E., recently Superintendent of Construction for J. E. & E. C. Wharf, Chicago, Ill., has been appointed Chief Engineer of the Peoria & Pekin Union Ry., with headquarters at Peoria, Ill., succeeding Mr. W. E. Emery.

Capt. Robert S. Griffin, U. S. N., has been appointed Chief of the Bureau of Steam Engineering, Navy Department, to succeed Lieut.-Com. H. I. Cone, who has been ordered to sea at the expiration of his four-year term on May 18. Capt. Griffin has been Assistant Chief of the Bureau of Steam Engineering for several years.

Mr. Lewis F. Pilcher, M. Am. Inst. Arch., has been appointed State Architect of New York. Mr. Pilcher was born in Brooklyn, N. Y., in 1871. He is a graduate in architecture of Columbia University. For a number of years was Instructor in architecture at Pennsylvania University and later Professor of Art at Vassar College. For the past two years he has practiced architecture in New York City.

Mr. John H. Delaney, former Business Manager of the "Morning Telegraph," of New York City, has been appointed Commissioner of Efficiency and Economy of the State of New York at a salary of $15,000 per annum. Commissioner Delaney has begun his work by appointing Mr. H. G. Lynn, of New York, and Mr. Matthew T. Horgan, of Brooklyn, Deputy Commisisoners, at salaries of $5000 per annum each.

Mr. E. A. Kingsley, Assoc. M. Am. Soc. C. E., recently County Highway Engineer, Pulaski County, Ark., has been appointed State Highway Engineer of Arkansas. Mr. Kingsley is a native of Indianapolis, Ind., and graduated from Purdue University in 1893. He has had experience with the city engineering department of Indianapolis and with the Great Northern and Chicago, Rock Island & Pacific Rys. For seven years following April, 1904, he was City Engineer of Little Rock, Ark.

Mr. J. W. G. Brewer, formerly Superintendent of Shops of the Baltimore & Ohio R.R., Mt. Clare, Baltimore Md., has been promoted to be Assistant District Superintendent of Motive Power of the main line district, with headquarters at Baltimore. Mr. Brewer entered the railway service in 1895 as a shop apprentice with the Baltimore & Ohio R.R. In 1905 he was a machinist in the Mt. Clare shops. In October, 1908, he was promoted to be foreman of the machine shop. He was made Assistant Master Mechanic in January, 1910, and Master Mechanic the following April. Since last September he had been Superintendent of Shops at Mt. Clare.

Major Cassius E. Gillette, of Philadelphia, Penn., has been appointed superintendent of construction of the Perry Memorial monument, which is to be built at Put-in-Bay, Ohio. The estimated cost of the monument, for which designs have been adopted, is about $1,000,000. A bill has recently been introduced in Congress to reinstate Major Gillette in the Corps of Engineers. Major Gillette resigned from the Corps a number of years ago at a time when he had been detailed by Secretary Taft to aid a reform administration in Philadelphia in its work of municipal house cleaning. Interests which were at that time influential in Congress introduced bills to prevent such a detail of an officer, and those in charge of municipal reform in Philadelphia persuaded Major Gillette

to resign his commission in order to continue in the Philadelphia work.

The Interstate Commerce Commission has announced the following members of the board of engineers who will supervise the work of making a physical valuation of the railways of the United States, provided for by recent Act of Congress: Mr. R. A. Thompson, M. Am. Soc. C. E., Chief Engineer of the California Railroad Commission; Prof. W. D. Pence, M. Am. Soc. C. E., Chief Engineer of the Wisconsin State Board of Assessment and the Railroad Commission of Wisconsin; Mr. J. S. Worley, Assoc. M. Am. Soc. C. E., Consulting Engineer, of Kansas City, Mo.; Mr. Howard M. Jones, M. Am. Soc. C. E., Consulting Engineer, of Nashville, Tenn.; and Mr. E. F. Wendt, M. Am. Soc. C. E., Assistant Engineer of the Pittsburgh & Lake Erie R.R. It is announced that it is the intention of the commission to add an officer of the Corps of Engineers, U. S. A., to the board later.

OBITUARY

John H. Weller, of Dayton, Ohio, former Superintendent of the Dayton & Michigan R.R., now a part of the Cincinnati, Hamilton & Dayton Ry., died Apr. 22, aged 83 years. His death was indirectly due to exposure during the recent flood.

J. Dwight Ripley, a retired railway contractor, of New York City, died in Denver, Colo., Apr. 27. He was contractor for parts of the Union Pacific R.R., the Delaware, Lackawanna & Western R.R. and the New York Central & Hudson River R.R. He retired from active business about 20 years ago.

Patrick Cahalin, a foreman on the construction of the first Panama R.R. during the days of the California gold rush, in 1854, died at Longbeach, Calif., Apr. 28. For many years he made his home in Deer Lodge, Mont., and was well known throughout the state and in Utah as "Panama Pat." He was 96 years old.

A. W. Quackenbush, formerly Master Mechanic of the Quincy, Omaha & Kansas City Ry., died at his home in Kansas City, Mo., Apr. 19, aged 68 years. He began as a machinist apprentice with the New York Central & Hudson River R.R. in 1862, and was promoted through various positions to that of Master Mechanic of different Eastern railways. Later he was Master Mechanic and Superintendent of Motive Power of several railways in the Middle West. He retired from active work in 1911.

George Harvey Fairchild, a consulting engineer, of San Francisco, Calif., died Apr. 21, while en route from Central America on the S.S. "City of Para." At one time Mr. Fairfield was Chief Engineer of the Omnibus Cable Co. and of the Market Street Ry Co., of San Francisco. Later he was connected with the engineering staff of the Pacific Mail Steamship Co. A short time ago he went to Guatemala to supervise the salvage of the steamship "Sesostris," which had gone ashore. He was 54 years old and is survived by a widow and two sons.

Gustave Wilhelm Wolff, for many years a member of the firm of Harlan & Wolff, famous British shipbuilders, died at his home in London, England, Apr. 15. He was born in Hamburg, Germany, in 1834. He was sent to England to Liverpool College, and to fulfill his father's desire that he become an engineer he was apprenticed to the firm of Joseph Whitworth & Co., of Manchester. After his apprenticeship was expired he became a draftsman in a small shipbuilding yard on Queen's Island, Belfast. Shortly afterward, in 1859, the business was purchased by Mr. (afterward Sir) Edward Harlan, who commenced work with a staff of 44 employees. Mr. Wolff was appointed Manager of the enterprise. The business of the firm grew tremendously, and in 1874 three more partners were added. Mr. Wolff severed his connection with the firm in 1908, when he sold out all his interests. At that time the number of employees was 12,000.

Charles Henry Tisdale, Assoc. M. Am. Soc. C. E., U. S. Junior Engineer in charge of the construction of Hales Bar Dam, Tennessee River, at Guild, Tenn., died in Mercy Hospital, Chicago, Ill., Apr. 30, from a trephining operation. Mr. Tisdale was stricken with apoplexy exactly one year before his death, and while he regained his health sufficiently to discharge his duties, he was frequently bothered with a recurrence of the disease. Thinking that he might get relief, Mr. Tisdale went to Dr. Murphy, the famous brain specialist, at Mercy Hospital, for an operation, which proved fatal. He was 38 years old and a man of exceptionally high standards and untiring energy. He was married in March, 1906, to Miss Lucy Vaughan, of Brusly, La., who died at Hales Bar the following year. Mr. Tisdale had been in the government service about 15 years, and had been in local charge for the government at Hales Bar for seven years. In his death the engineering profession loses a valued and esteemed member.—(Contributed by Roger B. McWhorten, U. S. Junior Engineer.)

James Tangye, M. Inst. M. E., who died in Cornwall, England, on Apr. 4, was born at the little village of Ilogan, near Redruth, on Oct. 6, 1825. He was one of the ablest of a remarkable family of brothers, of whom George Tangye now alone survives.

It is said of James Tangye by one of his brothers that, though he inherited some of the genius from his father, he had most of it from his mother, who came of a long line of Cornish engineers. Her father, Edward Bullock, had been chosen by William Murdock to take charge of the largest engine made up to that time by Boulton and Watt, and it was with Bullock that young Tangye obtained his first acquaintance with steam engines and pumps. Bullock owned a smithy, and it was to the mutual satisfaction of grandfather and grandson that the boy spent all his leisure time when not at school in his smithy. The former recognized the growing abilities of the youth, and the latter found his chief delight in life in being among engines and in being connected with anything to do with engineering matters.

In those early days lads were not kept long at school, and we find James Tangye at the age of 12 installed as Molliwig—or boy at everyone's call—at the Copperhouse Foundry at Hayle, near St. Ives, in Cornwall. Here he first came in contact with Brunel to whom later on he was destined to be of material assistance, and whose every movement he had observed with awe when, as an unimportant Molliwig, he himself was working at the Copperhouse Foundry.

Later on young Tangye spent a short time working for a wheelwright at Pool, principally, it is said, in order to build himself a tricycle! On leaving the millwright the youth found plenty to which to turn his hand at home without immediately seeking another situation. His father was a farmer, and there were wheels and plows and other things which had to be made or which needed repair. These accomplished, he struck out in another direction, which had to do with mining. Edward Wilkins was at the time engaged in developing and setting to work an improved method of dressing tin ore in the mines. This method was the invention of William Brunton, Sr., who was also the inventor of a walking locomotive for steep gradients. For some time James Tangye assisted Mr. Wilkins, and it was about this time that he constructed and put to work a waterwheel 18 ft. in diameter and 20 in. wide for driving a stamping mill. This wheel worked successfully for many years.

These and other such odd jobs kept the youth busy for some time, during which his retentive mind was continually storing up experience. A little later on William Brunton engaged him to construct some hydraulic pumps at Pool, and then he was for a year at the Redruth foundry, during which time a locomotive called the "Redruth" was built for the West Cornwall Ry.

In 1848 James went to Devonport in order to enter the service of Messrs. Distin & Chafe, who employed him in many urgent and important repair works with which they were entrusted by the Dockyard authorities. Here his foreman was a brother of Samuel Smiles, the biographer, and the tale is told of how that once when Smiles was absent a difficulty arose concerning the design of the parallel motion of a beam engine which was in course of erection. Apparently neither of the partners knew sufficient about engines to solve the problem themselves, and matters would have had to stand till Smiles' return had not young Tangye come forward and offered to undertake the work.

Later on Tangye was asked by Distin & Chafe to become their works manager, but he had made up his mind to return home so as to work together with his brother Joseph, who was then employed by William Brunton, Jr., in designing machinery for the quicker and better manufacture of blasting fuse.

The association between the two brothers, James and Joseph, was of the most cordial description, and, having now begun, it was destined to continue till the death of the latter. James being the designer and Joseph being the one to carry out the designs. The brothers remained with Brunton for some years, eventually becoming working managers and purchasing a small share in the business.

In 1858, James Tangye combined with his four brothers, Joseph, Richard, George and Edward, under the firm name of James Tangye & Bros., Machinists, Birmingham. The time was propitious. There was then in progress a tremendous advance in mechanical engineering. New problems were continually having to be faced, and James Tangye was just the man for the work. He had a wonderful gift for overcoming difficulties, and he rejoiced to meet and conquer them. He was endowed with a keen perception of the ultimate value